ETH BOARD

ANNUAL REPORT OF THE ETH BOARD ON THE ETH DOMAIN 2021

MISSION

The ETH Domain serves society through the pursuit of knowledge and the beneficial application of its science. The ETH Domain institutions share responsibility for education, research and knowledge and technology transfer. As degree-granting institutions, the technical universities ETH Zurich and EPFL play a leading role in Switzerland's educational system, and are supported in this role by the research institutes PSI, WSL, Empa and Eawag. With their thematically based activities, the research institutes offer continuity in knowledge and technology transfer.

The ETH Domain and its institutions
Higher education, research and innovations of the highest standard: the ETH Domain provides these services with over 24,000 employees, more than 36,000 students and doctoral students, and a pool of around 880 professors.

The ETH Domain consists of the two Swiss Federal Institutes of Technology ETH Zurich and EPFL, and the four federal research institutes: the PSI, WSL, Empa and Eawag. The strategic leadership and supervisory body of the ETH Domain is the ETH Board.
www.ethdomain.ch I www.ethboard.ch

ETH Domain

FACTS & FIGURES 2021

Students and doctoral students

36,110
Students and doctoral students

32.3%
Proportion of women

Employees

with employment contracts (EC)

14,789 Scientific personnel
4,102 Technical personnel
4,025 Administrative personnel

35.9%
Proportion of women

24,268
Employees
including professors, doctoral students and apprentices

465
Apprentices

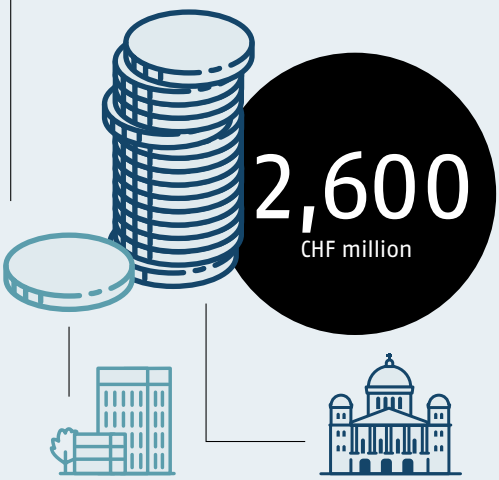
Professors

887

85 appointments, of whom
52 newly appointed persons
33 promotions

46.2%
Proportion of women among new appointments

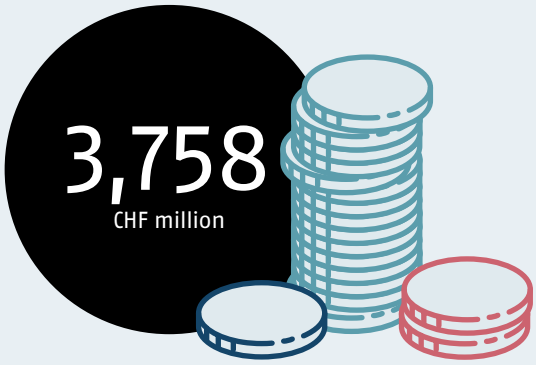
Total federal contribution[1]



Investment credit for buildings of the ETH Domain
CHF 227m

Federal financial contribution
CHF **2,373m**

Expenses



Investments **14.9%**

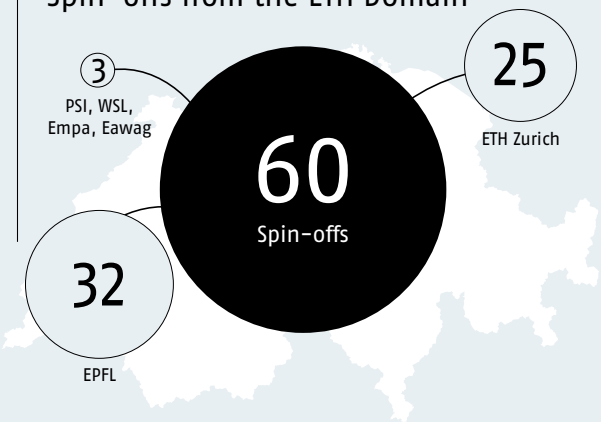
Personnel **65.3%**

Other expenses **19.8%**

Knowledge and technology transfer[2]

330	invention disclosures
39	software notifications
213	patents
181	licences
60	spin-offs

Spin-offs from the ETH Domain



Number of cooperation agreements[3]

272
Public sector

585
Private sector

University rankings

	THE World Ranking	THE Europe Ranking	QS World Ranking	QS Europe Ranking
ETH Zurich	15	4	8	4
EPFL	40	12	14	6

1 credits taking into account the expenditure ceiling
2 see also p. 97
3 with a volume of at least CHF 50,000 each

Annual Report of the ETH Board on the ETH Domain 2021

Financial Report:
www.ethboard.ch/financialreport2021

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Politicians and scientists should develop greater mutual understanding. And in the future, they need to cooperate more closely; not only in an emergency but also between crises. This is the conclusion reached by Federal Chancellor, Walter Thurnherr (right), and President of the ETH Board, Michael Hengartner, during their discussion.

ETH Zurich: quantum science

Quantum leap in quantum sciences

Quantum physical science has a long tradition at ETH Zurich. Now it is further expanding its teaching and research activities. Around 150 students are completing the novel Master's degree programme in Quantum Engineering, there is a "Quantum Center" and quantum computers are to be built in the ETHZ-PSI Quantum Computing Hub.

EPFL: profile of Anna Kiesenhofer

Talented mathematician and cycling sensation

Anna Kiesenhofer has a doctorate in mathematics and was doing research as a postdoc at EPFL on partial differential equations when she won the gold medal in the cycling road race in Tokyo in sensational fashion. She sees parallels between mathematics and cycling, which were instrumental in her success.

› Anna Kiesenhofer

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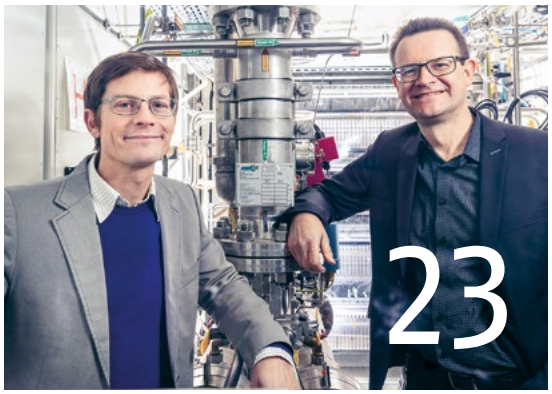
The ETH Board reports on the ETH Domain

Eventful start to the new ERI period

The coronavirus pandemic also demanded great flexibility in the teaching and research activities of the ETH Domain in 2021. The return to face-to-face teaching in the autumn semester was a milestone on the road to normalisation. The year was overshadowed by the EU's decision that Switzerland can only participate in the research framework programme "Horizon Europe" as a third country at the moment.



PSI: energy

"CO_2 can become a valuable resource."

The Swiss energy system is expected to be climate-neutral by 2050. The key to this is science: CO_2 can be converted by electrolysis to raw materials for chemicals or synthetic fuels.

WSL: isotope research

What isotopes reveal about climate change

Matthias Saurer is a physicist and heads the WSL isotope laboratory where complex measuring procedures are used to determine plants' isotope ratios. These provide answers to questions about the nutrient and water balance in forests, for example, and provide important foundations for environmental and climate research.

Empa: printed electronics

Electronics from the printer

"Printed electronics" is a growing scientific field in which an "invisible keypad", transistors and other electronic components can be printed on any substrate. Empa has become a leading name in this area. The Coating Competence Center (CCC) uses the latest printing techniques.

Eawag: natural toxins

From the arsenal of a bacterium

Cyanobacteria are ancient organisms. The most varied types of shells without a core, which, at high density in warm waters, can secrete complex substances and also toxins. Elisabeth Janssen (centre) is on the trail of these natural toxins.

FOREWORD

President of the ETH Board:
Michael O. Hengartner

Dear Readers

The coronavirus pandemic has dominated our daily lives during the past year. After several semesters of distance learning, students returned to the lecture theatres in the autumn semester – thanks to the COVID certificate. This was an important step. Students' motivation had suffered during the pandemic due to the lack of personal contact with lecturers and fellow students. They were now able to exchange ideas on site with other students and teachers, form study groups or continue working on their projects. The employees of the ETH Domain also worked more frequently again in their offices, labs and workshops, instead of working from home.

In 2021, the Swiss National COVID-19 Science Task Force established itself as an important scientific advisory panel. Since August 2021, Tanja Stadler, a professor at ETH Zurich, has been its President. Previously, Martin Ackermann, Head of the Department of Environmental Microbiology at Eawag and also a professor at ETH Zurich, had performed this role. The task force's work provided an opportunity to rethink the way scientists, authorities and politicians collaborate. For instance, the Parliament wants to better incorporate scientists in crisis management and facilitate authorities' access to their knowledge.

In addition, there is to be more extensive dialogue between scientists, politicians and administrators.

I see it as a duty of the ETH Domain to provide the best possible service to our country's business sector and society as a whole. That is why we are happy to provide our knowledge and expertise, and intensify the mutual exchange of ideas. There are enough issues and areas where there is a need to act: be it in relation to the climate, the environment and energy, digitalisation and cyber-security, or health.

The relationship between Switzerland and the EU remains an unsolved problem, but all the more urgent. Participating in the European Framework Programmes for Research and Innovation is key for education, research and innovation. The present exclusion from Horizon Europe cannot be compensated by national measures or greater cooperation with other countries. The international net-working, competitiveness, attractiveness and reputation of Switzerland's position as a centre of research and innovation will suffer directly, and the all the more the longer the exclusion applies. We must assume that researchers will move abroad or not come to our country at all anymore. This will lead to a substantial weakening of Swiss research, and our country runs the risk of gradually losing its leading international position. This would have serious consequences for uni-versities, public research institutions and the research industry.

As a pragmatic optimist, I hope that Switzerland will quickly achieve full asso-ciation status in Horizon Europe. I would like to thank everyone for their commit-ment to this cause and great support for the ETH Domain and our centre of vision and action in Switzerland.

Zurich/Bern, January 2022

Michael O. Hengartner,
President of the ETH Board

The ETH Board over the ETH Domain

EVENTFUL START TO THE NEW PROMOTION OF ERI PERIOD

The coronavirus pandemic also demanded great flexibility in the teaching and research activities of the ETH Domain in the 2021 reporting period. The return to face-to-face teaching in the autumn semester was a milestone on the road to normalisation. The year was overshadowed by the decision of the European Union that Switzerland can only participate in the research framework programme "Horizon Europe" as a third country at the moment. For the continuation of the outstanding research and innovation achievements in the ETH Domain, the return to full association status as quickly as possible is of crucial importance.

In the 2020 winter session, the Parliament, with the adoption of the ERI Dispatch for the period from 2021 to 2024, emphasised that education, research and innovation in Switzerland are of great importance. The ETH Domain also started the new ERI period, for which the Federal Council gave the six institutions of the ETH Domain a total of nine strategic objectives, with confidence. In terms of their content, these objectives are also characterised by continuity. For instance, as in previous periods, these objectives focus on first-class teaching, the leading position in research and the strengthening of Switzerland's capacity for innovation. With this focus, the ETH Domain aims to achieve maximum performance in the interests of science, business and society, and thereby also to give greater weight to sustainability.

Teaching: Return to face-to-face teaching

By the summer of 2021, the institutions of the ETH Domain had completed a total of three semesters of teaching primarily in online mode. The switch to digital teaching went smoothly and was completed within a very short period of time, whereby the fact that digital teaching methods had already been promoted over an extended period proved to be a major success factor. Despite this, it was clear to the managers of the two Federal Institutes of Technology that following the introduction of COVID certificates, the return to face-to-face teaching had to be the top priority. In the first few semesters in particular, the lack of opportunity for personal contact led to many students not really being able to gain a foothold and some having mental health issues. In the 2021 autumn semester, the two Federal Institutes of Technology therefore started with as much face-to-face teaching as possible. This gave the students the opportunity to meet colleagues on campus again on a regular basis and to form learning groups.

Research: COVID-19, climate and digitalisation

During the coronavirus pandemic, the research of the ETH Domain on SARS-CoV-2 was, as in the previous year, an important topic that was followed with interest by the public and the media. However, other key research fields have also increasingly returned to the spotlight, especially climate research and digitalisation. Both topics are also firmly enshrined in the strategic objectives of the Federal Council for the ETH Domain and are closely linked to ongoing social and political debates. Climate policy is one example where the Federal Council sent a new bill into consultation at the end of 2021 with which Switzerland intends to halve its carbon emissions by 2030 compared to 1990.

Politicians and scientists should develop greater mutual understanding. Federal Chancellor, Walter Thurnherr (right), and President of the ETH Board, Michael Hengartner, came to this conclusion in an interview (see also p. 12).

In addition to a range of different measures, new scientific findings and technological progress will also play an important role in achieving this objective. With their research activities in the fields of energy, mobility and buildings, the institutions of the ETH Domain are making a major contribution to the sustainable restructuring of the Swiss energy system. In the current ERI period, for example, the "Catalysis Hub" has started operating (see p. 60 ff. for this and other research infrastructure). This research infrastructure of several institutions of the ETH Domain, which is available to the entire Swiss research community, is intended to contribute to the production of new commodities through catalytic processing and the use of renewable energies. Quantum technology, biodiversity and a variety of other topics are also the main focus of research activities in the ETH Domain (see the chapter on Fascination ETH Domain, p. 11–34 and reporting on the strategic objectives, p. 49–88). The success of the institutions of the ETH Domain in their core fields of research, but also in teaching, was again reflected in the outstanding positions that the two Federal Institutes of Technology achieved in the university rankings in 2021 (see p. 99).

Research policy: Third-country status for Horizon Europe

Despite successful research and excellent international positioning, the start of the new ERI period for the ETH Domain was overshadowed by the difficult situation with regard to Switzerland's participation in the EU Research Framework Programme "Horizon Europe". Switzerland's current status as a non-associated third country has led to ETH Domain researchers no longer being eligible to participate in prestigious funding projects, such as ERC grants. Moreover, they can no longer manage any EU projects. As a result, Switzerland has lost the opportunity to help shape the development of the European Research and Innovation Area and to set priorities. With the loan for the "Horizon Package 2021 to 2027", the Parliament had also provided for (further) participation in ITER and Euratom and in Digital Europe. Switzerland's third-country status now also makes it impossible, for example, to coordinate Euratom collaborative projects or to participate in coordination and support actions. Although the ETH Board welcomes the measures taken by the Federal Council as the first important step in order to mitigate the negative consequences of non-association, rapidly obtaining full association status again is indispensable. The universities, research institutions and companies in the EU are the most important inter-

national partners of the ETH Domain. This cooperation cannot be replaced by simply signing more cooperation agreements with non-European partners. More than half of all international cooperation agreements of the two Federal Institutes of Technology are currently in place with our geographical neighbours, while 90% of the international contractual partners of some individual research institutions are based in the EU.

Knowledge and technology transfer: Strengthening Switzerland's innovation capacity

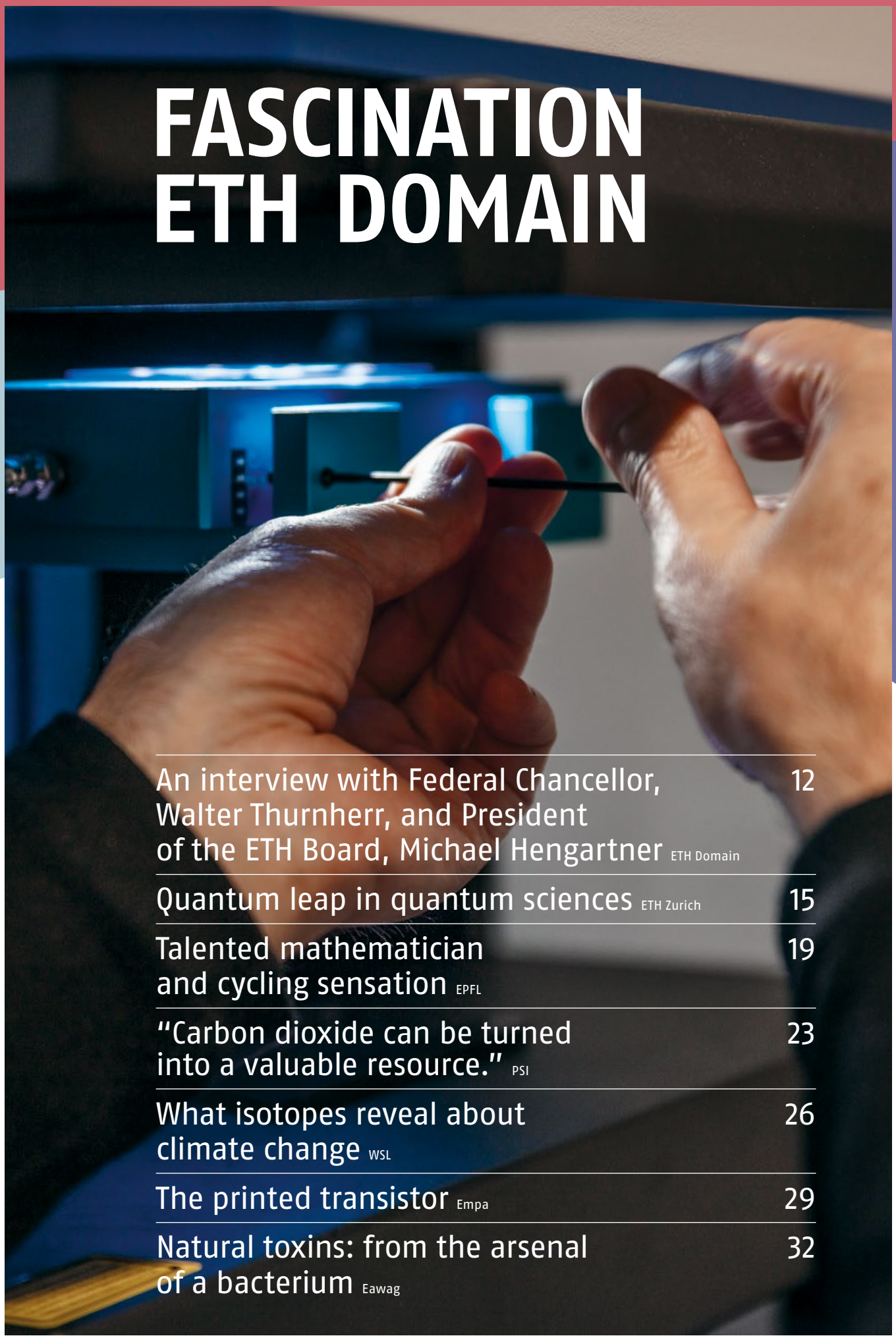
Measures to further strengthen the transfer of knowledge and technology (KTT) and Swiss innovation capacity are a key focus in the current ERI period, regardless of cooperation with Europe. As early as December 2020, the Federal Council initiated an analysis of the factors that are decisive for the efficiency of the local start-up ecosystem. Optimisation options for the KTT, the promotion of internationalisation, including access to specialists or a Swiss innovation fund to increase the growth opportunities of innovative companies, are currently being considered. These efforts are of great importance to the ETH Board since they are partially shaped by and go hand in hand with the commitment of the ETH Domain to strengthen Switzerland's position as a start-up and innovation hub. Exploiting the innovation potential resulting from research is not only in the genuine interests of the ERI institutions, but also directly contributes to the creation of new jobs. A recent study by BAK Economics on the Greater Zurich Area has shown, for example, that the universities play an important role in establishing the region as a more dynamic than average location, especially in the areas of IT and life sciences. The figures on patents and cooperation agreements of the institutions of the ETH Domain, and on the founding of spin-offs by them, once again prove this strength in 2021 (see p. 97 f.).

Science and politics

In addition to technology transfer, the transfer or dialogue between scientists and politicians is also an important area of responsibility of the ETH Domain. This is exemplified by the Swiss National COVID-19 Science Task Force, which again in 2021 supported the political authorities in their decision-making from the perspective of academia and research. After the transition to the "normalisation phase" in August 2021, Tanja Stadler, Professor in the Department of Biosystems Science and Engineering at ETH Zurich, was yet another qualified specialist from the ETH Domain to chair the Task Force. Following the adoption of a corresponding postulate of the Council of States, investigations are currently underway into how an interdisciplinary scientific network can improve cooperation between scientists and politicians with a view to managing future crisis situations (see also the interview on p. 12 ff.).

The dual autonomy of the ETH Board and the institutions of the ETH Domain leads to a constant negotiation of the scope, on the one hand within the area between the ETH Board and the institutions, but also between the ETH Board, politicians and the Federal Administration. However, this sometimes challenging exchange of views with well-thought-out and broad-based results contributes significantly to the stable framework conditions for teaching, research and innovation. This is also the conclusion of the historian, Urs Hafner, who shows in the brochure published at the end of 2021 entitled "Den Zufall steuern. Vom Schulrat zum ETH-Rat" (Controlling coincidence. From the School Board to the ETH Board) that both the ETH Board and the ETH Domain are complex structures that are "embedded in and permeated by Switzerland's finely balanced federal structure". The historian's analysis was conducted on behalf of the ETH Board but was written independently. It was also facilitated by the rapid progress of the "Focus project on providing access to the holdings of the ETH Zurich and the ETH Board" run by the ETH Zurich University Archives. In this project, physical administrative files from recent decades, including those of the ETH Board, have been made accessible for use as far as legally possible.

FASCINATION ETH DOMAIN



ETH Domain

"MORE DIRECT FACE-TO-FACE CONVERSATIONS BETWEEN SCIENTISTS AND POLITICIANS"

Politicians and scientists should develop greater mutual understanding. And in the future, they need to cooperate more closely; not only in an emergency but also between crises. Federal Chancellor, Walter Thurnherr, and President of the ETH Board, Michael Hengartner, came to this conclusion in an interview.

In the venerable Salon de la Présidence of the Federal Palace, Federal Chancellor, Walter Thurnherr, and President of the ETH Board, Michael Hengartner, met to discuss the relationship between scientists and politicians, which sometimes seemed to be heavily strained during the pandemic. But let us start from the beginning: What actually led to the creation of the Swiss National COVID-19 Science Task Force?

Michael Hengartner: We knew early on that the spread of the new virus would present a huge challenge. To overcome this challenge, we decided to rely on experts at our universities and research institutions. Within three days, we had secured the services of people from the six institutions of the ETH Domain. Then just a little later, we were able to connect with others with additional expertise from the cantonal universities and university hospitals. The whole formation process lasted less than two weeks, a terrific pace that we only achieved because so many people showed great a willingness to make a voluntary contribution.

Did politicians expect scientists to respond so quickly?

Walter Thurnherr: The possibility of a pandemic was actually discussed in the Federal Council twenty years ago. A major leadership exercise was conducted regarding the issue in 2005. However, in my opinion, the experience with avian influenza and the MERS and SARS epidemics shortly after the turn of the millennium contributed to the fact that the new virus wasn't taken seriously enough in Bern. Even at the end of February 2020, statements were made internally that "it cannot be ruled out" that the virus could spread in an uncontrolled manner. At that time, Taiwan had already put 250,000 people in quarantine. It wasn't until the end of February and early March that we started to limit gatherings to a maximum of 1,000 people. And the mandate which the Federal Council gave to the task force was signed on 30 March 2020, just before the first wave was already beginning to subside again in April. This was too late in my view. But the same applies to the pandemic as with other risks: people talk a lot about it, but when it actually occurs, everyone is still surprised.

What role do experts play in managing a pandemic?

Thurnherr: The Federal Office of Public Health had always been in contact with epidemiologists, but with the Science Task Force we now were given access to a broad network that was previously inaccessible. It's interesting to make the comparison with veterinary science and animal epidemics. Here we had to learn from experience with mad cow disease even twenty years ago and build a suitable network, which then helped us with

They agree that everyone benefits from greater cooperation. Federal Chancellor, Walter Thurnherr (left), and President of the ETH Board, Michael Hengartner, in the Salon de la présidence of the Federal Palace in Bern.

other animal epidemics such as the avian flu and bluetongue. Today, there is a record of where every single one of the 1.3 million pigs in Switzerland is from and where it was three months ago. Tremendous efforts have been made to create a data overview as quickly as possible with digital tools should an animal epidemic break out. During the coronavirus pandemic, we still have considerable deficiencies when it comes to data aggregation. At the onset, we could not even add up the number of COVID patients in good time.

Have the objectives of the task force changed over time?
Hengartner: Yes, and that was one of the major challenges. In the beginning, it was often a question of developing concrete solutions, such as diagnosis tests, and getting hold of the reagents required for this purpose. But with the mandate, the function changed: the task force became an advisory panel providing background information and decision making guidelines to the Federal Council. In the minds of the members, this change of role took place only gradually – and at varying speeds.

Looking back, I must say with self-criticism: as a supporting organisation, we should have been better at assisting the members of the task force, in order to promote understanding of the political process.

The team of experts had the task of answering questions from administrators or politicians, developing scenarios, presenting the current state of knowledge and generating options for decision-makers. However, taking decisions was clearly not a part of their role, rather it is a central and non-delegable task of politicians. Yet with exponential growth, time plays a critical role. For this reason, it does not surprise me that some representatives of the scientific community sometimes lost their patience. That their expasperation was so visible in the media surely has to do with the fact that we scientists have a tendency to attract attention ourselves – it is part of our profession to be visible. However, if politicians issue an advisory mandate, then they do not want to be publicly criticised afterwards by those who advised them. I can understand that too. Independent researchers are, of course, needed in Switzerland who also publicly express their opinion. However, advisers are also needed with whom you can have open discussions behind closed doors.

Thurnherr: Exactly what it means to "advise" is not clearly defined and that is why there were also conflicting ideas about it. That is why there is a difference between saying: "The incidences are developing in such a way that the new variant will probably be dominant in three to four weeks" or "In our view, the Federal Council should now introduce 2G to prevent the worst". At the beginning, in particular, that led to some scathing comments.

In addition, Parliament sent its members home in the first few weeks of the pandemic and, as a result, primarily people who nobody had seen before or nobody knew appeared at the media conferences. Democratically mandated politicians who usually occupy the public arena had to stay at home and watch the crisis being managed. It is therefore no surprise that the situation provoked them to ask why some expert or other was having more influence on what was happening than they had. And some could not understand why the scientific community was not always in agreement. Others even wanted to impose a public duty of silence on experts.

Fortunately, that wasn't a position with majority appeal.
Thurnherr: No. However, there is an observable trend: experts are now in a worse position than they were twenty years ago in this respect. On social media, absurd conspiracy theories are spread more easily and more quickly than scientifically differentiated theories. Of course, even experts are sometimes wide off the mark. I recently read that an expert committee in Switzerland concluded in 1958 that wars in Europe would no longer be conceivable without the use of atomic bombs, at which point the Federal Council publicly announced its intention to arm our country with nuclear weapons. But just because experts can be mistaken does not mean we should do without their expertise. On the contrary, for many issues we are reliant on more and not less expert knowledge. Be it genetic technology, cybersecurity or artificial intelligence, we need researchers who firstly can truly understand facts and explain them in such a way that politicians can also understand them, and secondly who understand that policymakers must take into account not only scientific factors but also other ones.

Do the duties of scientists who advise politicians differ depending on the issue?
Thurnherr: There are certainly points that apply to all issues. For instance, I believe there is a need for more direct face-to-face conversations between scientists and politicians. This is something both sides benefit from.

Hengartner: I agree entirely. Successful collaboration depends heavily on how you interact with each other and how well you understand how the system works. This also includes the need for politicians to know that science is a chaotic process, in which conflicting opinions struggle for control of the narrative.

Thurnherr: Yes, that's an important point. It's a process. Wolfgang Pauli, former professor at ETH Zurich, once said, "The best that most of us can hope to achieve in physics is simply to misunderstand at a deeper level". There have been repeated political voices demanding that scientists speak with only one voice. Yet it should actually be the other way round: the government should speak with one voice and not scientists.

What else have politicians and scientists learned from each other during the crisis?
Thurnherr: Politicians and scientists have drifted somewhat apart in the past. In the 19th century, when the administration was smaller, Switzerland made more direct use of the expertise of the universities and sometimes also sent university professors as ambassadors to international negotiations. In future, we should make better use of existing know-how by, for example, inviting researchers to hearings or parliamentary committee meetings more frequently. For me, one of the most important conclusions we can draw from the crisis evaluation to date is that we have to improve the institutional and informal relationship between politicians and scientists, not just in an emergency but also between crises.

Hengartner: I believe that an important lesson for scientists is to be more humble. Just because I'm an expert doesn't mean I have always the right answer. As a scientist, I am only credible for all sides if I remain cautious – and do not place my own value system above that of others. This is because greater dialogue also provides scientists with an opportunity to create trust. However, advisory activities tie up resources, which is why these activities must also be acknowledged in the academic environment. It is not acceptable for researchers who get involved to be told that they may give political advice in their free time, but that they will only be considered for promotion on the basis of the scientific papers they publish

In your opinion, what is required to reduce sources of friction?
Thurnherr: Politicians tend to refer to scientists particularly when their results confirm their own point of view. However, sometimes objection does them good, and people are not always right from the start. It is the responsibility of politicians to equip themselves with as much knowledge as possible before taking a decision. In many areas this is anything but easy because oftentimes it becomes apparent very quickly that the issue is more complicated than it seemed. And as I mentioned, researchers must know that politicians function differently and that many considerations must be made in parallel.

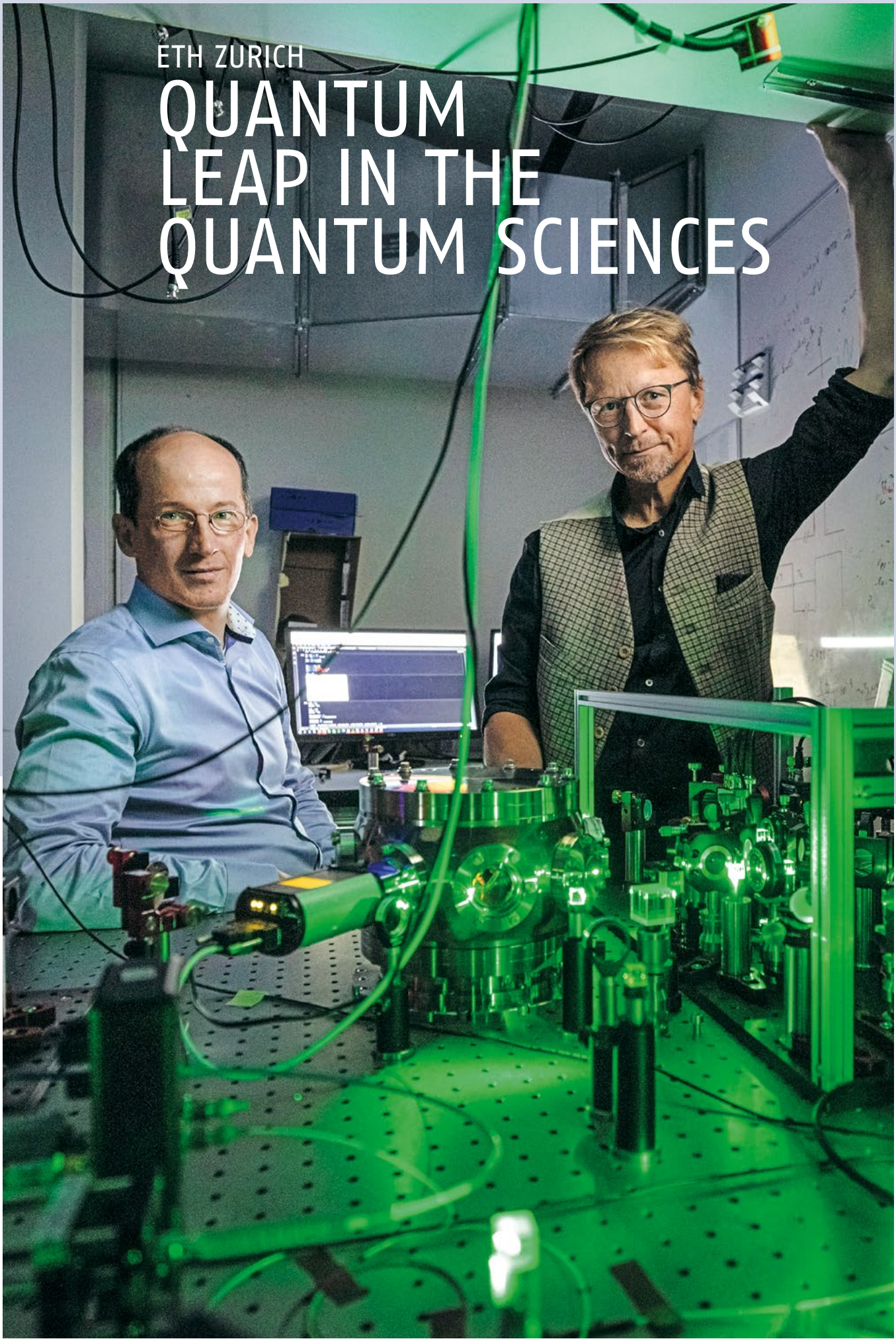
Hengartner: As this witty expression goes: you have to know a great deal about complex scientific topics in order not to have a firm opinion. However, I have to give the executive due credit: politicians always maintained dialogue, even in difficult times. It is a great honour to be able to play a key role in the decision-making process, which is rare for researchers.

Thurnherr: In Switzerland, we always hide our light under a bushel. Take the research of the two Federal Institutes of Technology or Tanja Stadler. Together with her team, she calculates the R value for half the world. It is an incredible achievement that we, as a small country, have so much expertise that we can call on. We should not forget that up to now we have come through the crisis relatively well. This primarily has to do with the ability to correct the course over and over again.

"Greater mutual understanding is needed and we should make better use of existing know-how."

– Federal Chancellor Walter Thurnherr

The interview was conducted on 15 December 2021.



ETH ZURICH

QUANTUM LEAP IN THE QUANTUM SCIENCES

Quantum physics has a long tradition at ETH Zurich. Now it is further expanding its teaching and research activities. Around 150 students are completing the novel Master's degree programme in Quantum Engineering, there is a "Quantum Center" and quantum computers are to be built in the ETHZ-PSI Quantum Computing Hub.

In addition to a considerable number of professors working on quantum physics and related technologies, ETH Zurich professors Lukas Novotny (right) and Andreas Wallraff are continuing to expand their teaching and research activities in quantum sciences.

What does quantum physics have in common with engineering sciences? Not much at first glance. The former is more about seeking explanations for the purpose of understanding natural phenomena. The latter is more interested in practical applications. ETH Zurich shows that a combination holds the potential to produce new findings and applications. In the autumn of 2019, the novel Master's degree programme in Quantum Engineering was launched and thanks to the "Quantum Center", which was initiated shortly afterwards, the various quantum research-related activities can be made more interconnected and more visible. There are now a considerable number of professorships dealing with quantum physics and related technologies. In May 2021, the ETHZ-PSI Quantum Computing Hub was then founded for the development of quantum computers.

Two people are representative of the combination of engineering and quantum sciences at ETH Zurich and the expansion of the latter. Lukas Novotny, Professor at the Department of Information Technology and Electrical Engineering and Programme Director of the recently launched Master's degree programme in Quantum Engineering, and Andreas Wallraff, Professor of Solid State Physics, founding director of the "Quantum Center" and Scientific Co-Head of the ETHZ-PSI Quantum Computing Hub. An engineer and a physicist. The fact that this concentrated expansion of quantum sciences is taking place at ETH Zurich is not an accident. Quantum physics has already existed for over 100 years. Originally, it was a matter of understanding natural microscopic objects, such as atoms. It was first-generation physicists, such as Max Planck and Niels Bohr, who established quantum physics as a field of science. Later, there were applications that would not have been conceivable without quantum physics: transistors, lasers or magnetic resonance imaging (MRI) – the first quantum revolution. In the 1980s, theoretical ideas emerged of using quantum physics in information technology, for computers, communication or better sensors – something like the second quantum revolution. "ETH Zurich has always been strong in these areas, as well as in the foundations and applications of quantum physics," is how Wallraff assesses the situation. "And now the combination of quantum physics with these fields is on the threshold of possible applications," added Novotny.

"At ETH Zurich, quantum physics and engineering sciences are of great importance. It was the 'golden moment' to build a new Master's degree programme for both fields of study."

› Lukas Novotny, Professor of Photonics

In this spirit, the new Master's degree programme in Quantum Engineering was the first of its kind to be developed. "We were aware that if we wanted to develop this field further towards application, the quantum scientists had to join the table of engineers," says Novotny, "because the physicist always wants to understand why and how something is the way it is, but does not necessarily have a practical application in mind. The engineer always wants to know: What can I do with it?" At ETH Zurich, where quantum physics and engineering sciences are of great importance, this was the "golden moment" to add a new Master's degree programme to the existing Bachelor programmes in both fields of study. It only took a few months from the initial idea to students' first rounds of applications – also because the Rectorate of ETH Zurich was well-disposed towards this project. The first graduates in Quantum Engineering will be in great demand. "I think 80 per cent will go into the private sector," said Novotny. The reason is that new developments in devices must become more and more handy, faster and more sensitive. If we extrapolate this trend forwards, this means that the development will push the boundaries of what is possible today and "that is where quantum mechanics begins," said Novotny.

It is likely that some time will pass before this results in a quantum leap which manifests itself in groundbreaking new applications. This is also evident where superconducting quantum computers are concerned, based on the way in which they are to be further developed at the ETHZ-PSI Quantum Computing Hub. These novel processors work differently than today's computers, namely on the basis of so-called quantum bits (qubits). "Qubits expand the scope to do things that are not possible with conventional computers," says Wallraff, "they push the limits of what is possible." However, building quantum computers is a complex matter, as they often prove to be error-prone. Researchers at ETH Zurich are currently running quantum computers with up to 17 qubits. For the next development stage, an existing building was especially converted for research on quantum computers on the PSI premises due to the know-how available there on the planning and operation of large-scale facilities. The medium-term goal is to build a quantum computer with 50 or perhaps even 100 qubits. However, in order to exhaust the potential, thousands, if not hundreds of thousands of qubits are needed. Pie in the sky? "Nobody can estimate today what will be possible with quantum computers in the future. However, many companies and researchers are very optimistic," said Wallraff, adding, "but above all, there are plenty of open scientific questions."

Nobel Prize winner transfers to ETH Zurich

Didier Queloz, winner of the Nobel Prize in Physics, is establishing a new research centre at ETH Zurich.
› Keystone

In 1995, the young Geneva astronomer, Didier Queloz, and his doctoral advisor, Michel Mayor, discovered the first exoplanet orbiting a solar-type star. In 2019, the researchers were awarded the Nobel Prize in Physics for their groundbreaking discovery. Now, Queloz (currently aged 55) is going to be the first director of the new "ETH Center for the Origin and Prevalence of Life". In this facility, researchers from different disciplines will jointly investigate the origins of life. Important progress has been made in recent years – not only in astronomy, but also in biochemistry and molecular biology. This is now to be used to help uncover the mystery surrounding the origin of life.

150 years of agricultural science

Read more.

In 1871, the Division of Agriculture was founded at ETH Zurich and started with three professors and five students. However, the subject area soon made great headway, which over time also led to structural adjustments. Finally, in 2012, agricultural sciences were integrated into the new Department of Environmental Systems Science – a decisive step in recognising the subject as a systemic science. "Today, agricultural sciences are a whole range of disciplines," explains Emmanuel Frossard, Professor of Plant Nutrition at ETH Zurich since 1994. "While the priority used to be ensuring sufficient production, now it is about optimising multifunctional, environmentally friendly agriculture."

Agricultural research is increasingly relying on robotics and artificial intelligence to address current problems: the weeding robot "Rowesys", developed by mechanical engineering students.
› obs/AWK Group AG/ Immanuel Denker

Using technology to strengthen diplomacy

Develop new technologies and make the best use of them for diplomacy: this is the goal of the "Lab for Science in Diplomacy" (SiDLab) in Geneva, which ETH Zurich and the University of Geneva jointly founded in October 2021. The interdisciplinary research centre brings "negotiation engineering" and computational diplomacy under one roof, with the aim of providing scientific insights and methods for the diplomatic resolution of international conflicts and contributing to overcoming global challenges. The SiDLab will strengthen Switzerland's position as a centre for scientific excellence and Geneva's position as a hub for multilateralism.

ETH Zurich and the University of Geneva established the Lab for Science in Diplomacy in the internationally renowned city of Geneva.
› UNIGE/Marco Cattaneo

Glacier retreat is accelerating

Melting glaciers are an obvious indicator of climate change. However, the extent has so far been only partially measured. An international research team led by ETH Zurich and the University of Toulouse has authored a comprehensive study on global glacier retreat for the first time. For the study published online in the journal *Nature* on 28 April 2021, the team led by first author Romain Hugonnet investigated satellite images of approximately 220,000 glaciers. The result: between 2000 and 2019, the glaciers lost an average of 267 gigatonnes of ice per year, an amount that would submerge Switzerland under six metres of water. Glacial retreat causes up to 21 per cent of the rise in sea levels observed every year – and the process is accelerating rapidly: whereas between 2000 and 2004, glaciers lost 227 gigatonnes of ice per year, between 2015 and 2019, this figure had already risen to 298 gigatonnes.

Under this suspension bridge in the Valais, the glacier tongue of the Corbassière Glacier was still present in 2014. In September 2021, all that remains is a desert of stones and gravel.
› Peter Rüegg

Anne Lacaton awarded the Pritzker Prize

Anne Lacaton, Emeritus Professor at ETH Zurich, and her partner Jean-Philippe Vassal, were awarded the Pritzker Prize (the most important prize for architecture) on 16 March 2021. In the eyes of the jury, the French architectural team's work is unique in the way it succeeds in responding both to the environmental challenges of our time, and to social priorities. Lacaton and Vassal are pioneers of sustainable architecture: they avoid demolishing buildings, working with existing structures wherever possible. The architecture office, founded in 1987, has already completed more than 30 projects. One of their most renowned architectural achievements was the renovation and expansion of the Palais de Tokyo in Paris.

Student Project House opened

A smart white cane or a self-sustaining house run via blockchain: this and many other ideas have already been realised by students in the new Student Project House next to the main ETH Zurich building. It is the second laboratory of ideas since the pilot project was launched on the Hönggerberg campus in 2016. The newly renovated rooms, with a total area of 1,200 square metres spread out over five storeys of the former district heating power plant, enable students to realise their ideas away from the pressure of marks. In addition to numerous co-working spaces and common rooms to promote creative exchange, a workshop is also available. Students also benefit from coaching opportunities and workshops.

Here you can find the YouTube video.

Students will find plenty of space and technical equipment to implement their ideas in the Student Project House.
› Jasmin Frei / ETH Zurich

Anne Lacaton, Emeritus Professor at ETH Zurich, was awarded the Pritzker Prize. It is considered the Nobel Prize in Architecture.
› Laurent Chalet/ Philippe Ruault

EPFL

TALENTED MATHEMATICIAN AND CYCLING SENSATION

Austrian Olympic Committee – editorial use free of charge

Anna Kiesenhofer has a doctorate in mathematics and was doing research as a postdoc at EPFL on partial differential equations when she qualified for the cycling road race at the Olympic Games in Tokyo and won the gold medal in sensational fashion. She sees parallels between mathematics and cycling which were instrumental in her success.

"A maths genius who just pulled off one of the biggest shocks in Olympics history." That is what CNN wrote about Anna Kiesenhofer, mathematician and gold medal winner at Tokyo 2021

See the last metres of the race.

Anna Kiesenhofer's greatest passion is mathematics. There is a drawing on her homepage: mathematical formulas are in the background. In front of them, there is an image of her, sitting upright in a victory pose on her racing cycle. Cycling is her second-greatest passion, and it took her to the Olympic Games in Tokyo in 2021. She describes herself as a "mathematician & cyclist. Born and raised in Austria. Living in Lausanne since 2017. Minimalist, introvert, attracted by the uncommon. Tokyo 2021 gold medal." Her slogan is: "Dare to be different". Different in order to achieve the unusual – that is something like the short formula of Anna Kiesenhofer's life of thirty years so far.

It was initially characterised by her greatest passion, mathematics. Kiesenhofer chose to study this subject "because it is more exact than physics". She graduated from the TU in Vienna with a bachelor's degree and then graduated from the University of Cambridge with a master's degree in "Pure Mathematics"; during this period, she was a keen triathlete. In 2016, science and sport moved closer together: at the Universitat Politècnica de Catalunya in Barcelona, Kiesenhofer was awarded a doctorate for her dissertation on "integrable systems on b-symplectic manifolds" with the top mark of "excellent cum laude", studied "abstract mechanical systems which can be described in mathematical spaces" and "wanted to progress in the academic world". After an injury, she transferred her sporting ambitions to the bicycle and won her first national elite road race in Spain in the year she completed her doctorate. Sport became an increasingly important part of her life. She even signed a contract with a cycling team, but soon realised that "life as a professional athlete is not for me." She thus progressed down the academic path, which seemed to be predestined for her, and started working as a scientific employee at EPFL in Lausanne because she could continue working there on her research focussed on partial differential equations at a first-class address and, as a postdoc, also teach on various Bachelor's degree programmes. Another piece of the puzzle on the way to an academic career.

"In cycling, the mathematical is also always present: it's about aerodynamics or technical developments. About individual performance potential that can be optimised via modelling."

› Anna Kiesenhofer

Then came the watershed year of 2021. After an internal elimination, she was given a starting place for the Olympic road race. The amateur was the only one to represent the colours of Austria, while other nations lined up with professional teams and half a dozen cyclists. Kiesenhofer competed all on her own: without a coach, without a team, relying only on her strengths and building on her own training plans, which she implemented with discipline, willpower and scientific meticulousness. And above all: she was aware of her above-average endurance. With this level of focus, she started the 137-kilometre race and was in the lead from the start to the finish. "Three factors were decisive for my Olympic victory," analyses Kiesenhofer soberly, "I attacked immediately and my opponents underestimated me, thinking they would catch up with and overtake me later in the race. However, I didn't slow down and was able to make full use of my endurance." And then, of course, she also had the necessary amount of luck on her side. The cycling world went wild with excitement. The American TV channel CNN wrote about Kiesenhofer: "A maths genius who just pulled off one of the biggest shocks in Olympics history." The media shock waves reverberated all the way to the *Times of India*, the *Arab Times* and the *China Daily Global*, and in Austria she was named the "Sportswoman of the year".

Her Olympic gold medal changed everything. She now receives the government funding for which her achievements before Tokyo had not been good enough. Now she can say with complete conviction what she had never dared to claim before: "I am a professional athlete." What's more: at EPFL in Lausanne, which is also the centre of her private life, her postdoctoral position has expired. And so professional sport is now her main focus. This does not mean that her academic ambitions have been completely forgotten. The parallels between science and sport are too obvious for Kiesenhofer: both require passion, focus, precision and discipline. And in her sport of cycling, mathematics is always present as well. For instance, it is about aerodynamics or technical developments. About individual performance potential that can be optimised via modelling. What the CNN headline suggests is perhaps not even completely wrong: the fact that with Kiesenhofer a mathematician became the women's Olympic road cycling champion is not only the result of an extraordinarily robust physique. And that is why it is also clear what she has in mind after her career as a professional athlete: she wants to get involved in sports science. "Then I will need something for my brain," says Kiesenhofer knowingly. Or as it says on her website: "Dare to be different."

Explore the universe with virtual reality

A 20-minute film entitled "Archaeology of Light" is already available on YouTube and from 21 April 2022, it will be screened at EPFL Pavilions.
› Hadrien Gurnel/eM+

Have you always wanted to explore outer space? Now you can, without leaving Earth, thanks to the powerful, open-source beta software VIRUP that builds – in real-time – a virtual universe based on the latest astrophysical and cosmological data. You are floating in space, just above the Earth. The International Space Station is just an arm's length away. You turn your head around only to see the moon, a tiny circle, far off in the distance. This is probably exactly what an astronaut would see during a spacewalk. This is the beginning of a journey into outer space, in a virtual environment developed by EPFL scientists. Now, for the very first time, you can enter the most comprehensive virtual universe, thanks to powerful, open-source software developed at EPFL's Laboratory of Astrophysics (LASTRO). The software VIRUP, the name stands for Virtual Reality Universe Project, is a first beta version was released on 1 November 2021. VIRUP is also capable of building a virtual universe in other VR environments, for example in a dome, which is especially useful for venues like planetariums or caves. The transition from the rather personal and isolated experience of VR goggles to the collective, theatrical experience became possible thanks to a collaboration between LASTRO scientists and EPFL's Laboratory for Experimental Museology (eM+).

Building out of concrete, but without pouring concrete

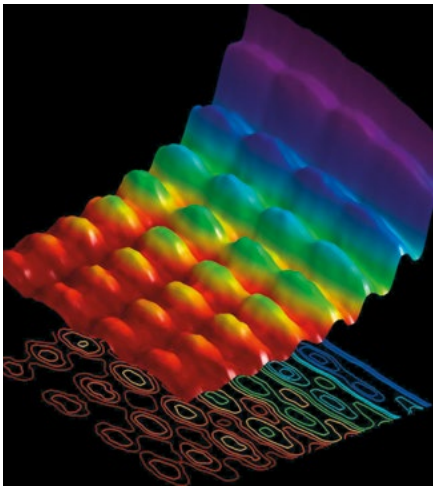
EPFL researchers have built a footbridge prototype using reinforced-concrete blocks from walls of a building being renovated. The blocks were cut into individual pieces on site and then assembled into a prestressed arch. This project, which marks the first time concrete has been reused in this way, is part of a research initiative aimed at substantially reducing the construction industry's carbon footprint by adopting a circular economy approach. The footbridge was inaugurated at a ceremony at the Smart Living Lab in Fribourg on 11 October 2021.

The prototype of the pedestrian bridge – also on YouTube.
› EPFL

New highly potent neutralising antibody against SARS-CoV-2

Lausanne University Hospital (CHUV) and EPFL have discovered a highly potent monoclonal antibody that targets the SARS-CoV-2 spike protein and is effective at largely neutralising all variants of the virus identified to date, including the delta variant. Their scientific study was published in the prestigious journal Cell Reports. The newly identified antibody was isolated using lymphocytes from COVID-19 patients enrolled in the ImmunoCoV study being carried out by CHUV's Department of Immunology and Allergy. This antibody is one of the most potent identified so far against SARS-CoV-2. Based on these promising results, CHUV and EPFL have signed cooperation and intellectual property rights agreements with a start-up company which will be responsible for clinical development and production of the newly discovered antibodies. Clinical trials of the drug should begin in late 2022.

The first ever photograph of light as both a particle and wave



Light simultaneously showing spatial interference and energy quantisation.
› Fabrizio Carbone / EPFL

Quantum mechanics tells us that light can behave simultaneously as a particle and as a wave. Since the days of Einstein, scientists have been trying to directly observe both of these aspects of light at the same time. However, there has never been an experiment able to capture both properties of light at the same time. The closest we have come is seeing either a wave or a particle, but always at different times. Taking a radically different experimental approach, EPFL scientists led by Professor Fabrizio Carbone have now been able to take the first ever snapshot of light behaving both as a wave and as a particle. The pioneering work was published in Nature Communications.

Mass scale manipulation of Twitter Trends discovered

Social media has become ubiquitous in our modern, daily lives. It has changed the way that people interact on a daily basis, connecting us in previously unimaginable ways. Yet, where once our social media networks probably consisted of a small circle of friends, most of us are now part of much larger communities that can influence what we read, think and do. One influencing mechanism, for example, is "Twitter Trends". The platform uses an algorithm to determine hashtag-driven topics that become popular at a given point in time, alerting Twitter users to the top words, phrases, subjects and popular hashtags globally and locally. EPFL researchers have discovered that almost half of local Twitter trending topics in Turkey are fake. It was therefore also possible to prove for the first time that many trends are created solely by bots due to a vulnerability in Twitter's Trends algorithm, which decides Twitter trending topics but does not take deletions into account. This allows attackers to publish tweets containing a keyword, push these to the top of Twitter Trends and then immediately delete their tweets afterwards.

EPFL is building an experimental Hyperloop

EPFL and its start-up Swisspod are building a Hyperloop on the Campus in Ecublens to test the ultra-high-speed vacuum transport technology. In particular, this will allow for tests to be conducted on a linear induction motor. The research is being funded by an Innosuisse grant. Hyperloops, viewed by some as the fifth mode of transport, which offer a cleaner alternative to planes and are faster than trains, stand to revolutionise long-distance travel. More and more Hyperloop projects are being launched around the world from the Nevada desert to the Port of Hamburg, Toulouse, the Middle East and China. The test track in Ecublens is Europe's first operational model Hyperloop and is shaped like a cast aluminium ring with a diameter of 40 metres and a length of 120 metres. The ring is full of sensors – a novelty in Europe. The test track was developed and managed by EPFL's Distributed Electrical Systems Laboratory (DESL) and will make it possible to simulate an infinitely long Hyperloop.

The infrastructure is shaped like a cast aluminium ring with a diameter of 40 metres and a length of 120 metres.
› Murielle Gerber / EPFL

PSI

"CARBON DIOXIDE CAN BE TURNED INTO A VALUABLE RESOURCE."

The Swiss energy system is expected to be climate-neutral by 2050. The key to this is science: CO_2 can be converted by electrolysis into raw materials for chemicals or synthetic fuels and the cost of a fossil-free energy system can be calculated using modelling.

"The use of CO_2 as a commodity can make a substantial contribution to climate protection and the energy transition."

› Thomas Justus Schmidt, Head of the Energy & Environment Research Division (left) with Tom Kober, Head of the Energy Economics Group at the Laboratory for Energy Systems Analysis.

Great challenges, but also clarity about what needs to be done. This is because at the PSI, chemical, technical and economic expertise is combined at a high level.

Thomas Justus Schmidt is a chemist with a doctorate, a professor of electrochemistry at ETH Zurich and Head of the Energy & Environment Research Division at PSI with the Energy Economics Group at the PSI's Laboratory for Energy Systems Analysis. Industrial engineer, Tom Kober, who holds a doctorate in the field of energy economics and heads the Group, says "I have two great passions: technology and economics." Both are working on the question: How can the Swiss energy system be decarbonised and converted to climate neutrality in accordance with the Energy Strategy 2050? Chemistry and technology are necessary for the concrete replacement of fossil energy sources and the long-term storage of electricity from renewable energy sources. Economics shows the associated costs.

The substance involved is carbon dioxide or CO_2. It occurs naturally in the Earth's atmosphere, but it is also created by the burning of wood, coal, oil or gas as well as in industrial processes. Once released, CO_2 does not break down itself – it is physically stored by water bodies or broken down by green plants via photosynthesis. Since the middle of 20th century alone, global CO_2 emissions have quadrupled, overwhelming the natural carbon sinks and increasing the greenhouse effect.

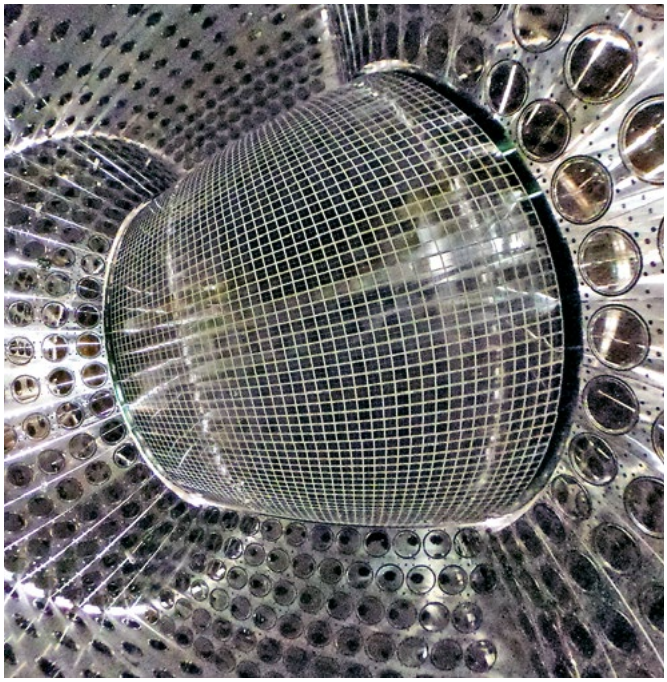
"Carbon dioxide can be turned into a valuable resource": this was the surprising headline of a PSI media release in 2021. Volatile, climate-damaging carbon dioxide as a suddenly valued commodity? What sounds like witchcraft "is chemistry," says Schmidt succinctly. CO_2 is captured from the atmosphere or at the source. Just as CO_2 is produced in a combustion process, "it is also possible to reverse this process, which can lead to raw materials for chemicals or synthetic fuels being created again," explains Schmidt. Via electrolysis, a process that causes CO_2 to react with water to form valuable chemicals is triggered by an electric current.

Schmidt is convinced that "the use of CO_2 as a commodity can make a substantial contribution to climate protection and the energy transition." However, the electrolysis route must be energy efficient, the electricity must come from renewable sources, and ultimately more CO_2 must be retained than is released. An electrolysis cell developed at the PSI shows that even with the current Swiss electricity mix, carbon monoxide (CO), an important raw material for the production of synthetic fuels, can already be produced "which has the potential to reduce CO_2 emissions," emphasises Schmidt. Processes that function reliably in the laboratory are now on the threshold of larger scale production. There is also great potential in the production of synthetic fuel for air traffic, where decarbonisation is particularly difficult. However, thanks to the interdisciplinary research of the SynFuels initiative between PSI and Empa, they have also succeeded in producing small amounts of synthetic fuel in the laboratory.

Electricity is the key to the non-fossil energy future. In this context, storage technologies play a key role, while consumption is increasing at the same time. "Storing electricity directly over extended periods of time is extremely expensive," explains Schmidt, adding the "path to long-term storage is via the storage of electricity in the chemical bonding of molecules, such as hydrogen, synthetic natural gas and other fuels or even methanol." Chemicals can be used to store electricity for long periods. Production is becoming more decentralised and the plants are getting smaller. Corresponding technologies are already available on a laboratory scale. These must now be translated into viable economic business models.

However, how much will it cost Switzerland to move to net zero emissions by 2050? Model calculations by Kober show that additional costs of around CHF 300 per year per capita are required for this purpose. "These are the extra energy costs in addition to those we have in comparison with a reference development, in which climate protection plays a comparatively minor role," says Kober, adding that "the costs refer to all energy system costs for mobility, buildings and industry." This holistic approach shows how far-reaching such a transformation of Switzerland's energy system is. The installed capacity of photovoltaic plants, for example, must double every decade until 2050, and electricity generation from power stations and storage systems must be increased by at least one fifth, assuming that all nuclear power stations are decommissioned by 2045. The fact that every individual needs to do their part is shown, for example, by the fact that by 2030 every third new registration of a car will have an electric engine and that electric vehicles must be introduced more or less across the board by 2050. Space heat generation must also be converted from current fossil fuels to electric heat pumps on a large scale and as many potential savings as possible must be exploited.

The search continues



The liquid xenon photon detector used as part of the MEGII Experiment at PSI.
› PSI

From CERN to Fermilab, everyone is looking for the muon that contradicts physics. At PSI, the international MEGII collaboration is ready for launch after nine years of meticulous upgrading. The experiment examines whether the muon, an elementary particle, can break down into an electron and a photon, which breaks the laws of the current Standard Model of particle physics. In the search for the needle in the haystack, the experiment can detect even just one such decay among a hundred thousand billion muons. Equipped with the world's most intense continuous muon source, the Swiss Muon Source, and with detector upgrades that enable an unprecedented level of sensitivity, MEGII is changing our understanding of the smallest building blocks of matter.

Protons help to fight lung tumours

Visit the Center for Proton Therapy on YouTube.

In November 2021, a patient with a lung tumour was treated with protons for the first time at the Centre for Proton Therapy in Switzerland. The treatment was carried out as part of an international study in which PSI, together with the Radio Oncology Centre of the cantonal hospitals of Aarau and Baden, are the only institutions outside the USA to take part. The study compares the success of treatment with conventional radiotherapy with that of proton therapy in the most common form of lung cancer – in the advanced, inoperable stage. With this treatment applied for the very first time, PSI has opened the next chapter in the very successful history of proton therapy.

Dominic Leiser, the treating radio oncologist of the first patient whose lung tumour was irradiated with protons at PSI.
› Markus Fischer/PSI

SwissFEL pulse: quicker than water freezes

PSI researchers have measured the isobaric specific heat of water during severe undercooling. The maximum value is −44.15 degrees Celsius and then decreases rapidly. This supports the theory that water itself is a mixture of two fluids with different densities – a possible reason for the thermodynamic anomaly, without which life on Earth, as we know it, would not exist. Measurements were previously impossible, as water immediately forms ice crystals at such low temperatures. The SwissFEL offered the solution: an infrared laser pulse triggered an ultrafast temperature jump in undercooled water droplets, which were then measured with X-ray pulses at temperatures of as low as −46.15 degrees Celsius.

Frozen water drops
› Shutterstock

WSL

WHAT ISOTOPES REVEAL ABOUT CLIMATE CHANGE

Matthias Saurer is a physicist and heads the WSL isotope laboratory where complex measuring procedures are used to determine plants' isotope ratios. These provide answers to questions about the nutrient and water balance in forests, for example, and provide important foundations for environmental and climate research.

"Isotopes are a constant factor in my life as a researcher," says Matthias Saurer, who heads the WSL isotope laboratory in Birmensdorf where several mass spectrometers are located. "Isotopes are atoms of an element that have different amounts of neutrons in stable or radioactive form and thus different masses. Mass spectrometers in the laboratory make it possible to examine isotopes of carbon, hydrogen, oxygen or nitrogen, which are naturally present in the environment," explains the scientist. In this way, isotope ratios can be determined and high-resolution isotope analyses of organic material can be carried out, which is useful in very different research areas. "It is a matter of being active at the forefront of research with ever more precise methods and conducting basic research," explains Saurer. This can help us to better understand complex changes in nature, such as the dramatic decline in biodiversity caused by various factors. Or the effects of increasing and more frequent droughts in the forest. This results in findings that ultimately provide the basis for official measures to protect nature and the foundations of human life.

Saurer is also synonymous with the development of isotope research on the climate and ecology. At the University of Bern's Physics Institute, he received a doctorate for his research on isotopes and used the mass spectrometer early on. Later, he was involved in the development of this methodology at the PSI's Laboratory of Atmospheric Chemistry. During this time, an increasing interest in stable isotopes developed in forest and environmental research, resulting in close cooperation with WSL. In 2017, Saurer was able to transfer the measuring devices and his workplace from the PSI to WSL, where he became head of the newly created isotope laboratory: this enabled the measurement technology from physics and the expertise in research on forests and landscapes to also be brought together in a single location. Isotope research is complex and the isotopes in plants have a cross-divisional function. For instance, other disciplines play a major role in any scientific issue. In forest research, for example, these include biology and climatology. For the understanding of the processes in plants, this applies to chemistry or biochemistry. With the interdisciplinary approach and the instruments of mass spectrometers, isotope research contributes to a better understanding of often hidden processes in nature and researchers at the isotope laboratory can answer a whole series of important questions. For example, the nutrient and water balance in forests. More specific analyses can also be used to examine individual components such as sugar in leaves or tree needles, in which the various isotopes of carbon and oxygen are absorbed through photosynthesis. In the case of dryness, their isotope signature changes, which then also enters the wood and is permanently stored there. Therefore, the isotope researcher is very interested in understanding what happens in tree needles when the climate changes.

One traditional application is research on trees' growth rings. For example, the isotope laboratory was involved in 2020 when an international research team analysed over 27,000 measurements of the isotope ratios of oxygen and carbon in 147 European oaks using growth rings spanning a period of more than 2,000 years. The tree samples come from historic wells, buildings or pile dwellings, from river bank sediments and living trees in the Czech Republic and Bavaria. It is the most detailed collection of data on the hydroclimatic conditions from the Roman Empire to the present day.

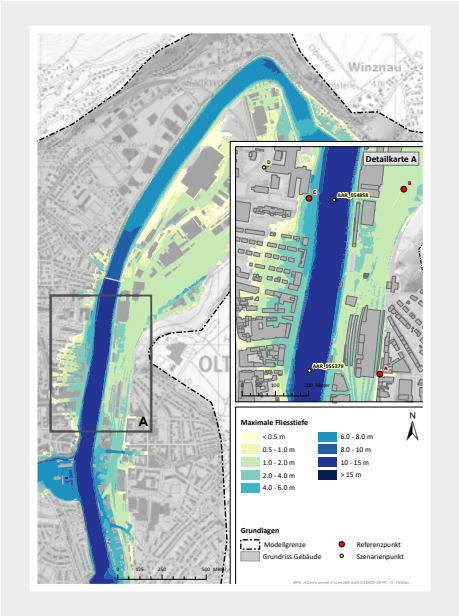
Conclusive evidence of climate change? The elaborate history of the trees spanning two millennia and the measured isotope ratios suggest that the dry periods of the past five years have actually been exceptional.

"There are different levels of certainty when it comes to statements about climate change," says Saurer, "it is clear that the increase in carbon in the atmosphere is caused by humans, as is the associated rise in temperatures. But even in the case of torrential rain, clear statements are more difficult." The reason is that precipitation is a very heterogeneous phenomenon involving regional, often only localised events. Establishing a clear causality between heavy rain and the increase in carbon is not easy. However, isotope research also helps where this is concerned. "Our growth ring analyses always produce important new findings relating to this issue," says Saurer.

"Isotope research is basic research to better understand hidden processes in nature. For example, what happens in the tree needles when the climate changes and how this signal is stored in the wood."

› Matthias Saurer, Head of the WSL isotope laboratory

What happens if there is an extreme flood event on the River Aare?



The "Extreme flood events on the River Aare" (EXAR) project provides a basis for assessing the risk posed by very rare extreme flood events which, statistically speaking, occur only once every 1,000, 10,000 or even 100,000 years. This means that authorities and operators of facilities, such as the Olten Railway Station, the PSI site in Villigen, or the Mühleberg, Gösgen and Beznau nuclear power stations, have a sound basis for providing better protection to the population and infrastructure. WSL coordinated the study, which was launched by four federal offices and the Swiss Federal Nuclear Safety Inspectorate (ENSI), and wrote short versions with the most important findings and results in German, French, Italian and English, in addition to the main report.

In case of a one in a 100,000-year flood, Olten Railway Station would be half a metre under water.
› WSL reports 104, 2021

View the WSL reports here.

New survey method supports climate-smart forestry

Recognising how trees respond to drought is the key to understanding the impact of drought on forests and identifying species that can survive climate change. Until now, such observations have been made by examining individual trees, which is very time-consuming. As part of a Swiss National Science Foundation (SNF) study, WSL researchers have for the first time used drones to perform measurements of the photochemical reflectance index (PRI) in a novel way. This indicator of thermal energy dissipation during photosynthesis can be identified by multi-spectral imaging. This is a method that can be used to display physiological processes that the human eye does not perceive. The new drone-based survey method allows the state of health of an entire forest to be mapped within a short space of time.

Whether drought stresses trees can be determined efficiently and over wide areas thanks to drones and multispectral analyses.
› Fredrik Baumgartner/WSL

Book recommendation: hiking where others research

The WSL walking guide in German and French features eight walks which provide access to the most important WSL research sites in the Canton of Valais. Those who follow the routes can, for example, get to installations used for early detection of debris flows or to the ecologically very well-researched forest fire area at Leuk and find out about a variety of scientific background information. The sun-drenched canton is a kind of early-warning region for climate change. This makes the climate stories that can be read from wooden beams of old Lötschental houses or wandering through the Pfynwald forest, where the WSL is conducting a unique irrigation experiment, even more exciting. The smartphone app helps users when they are out and about to find their way and provides interesting facts about the fauna, flora and geology.

The book was published at the same time in both German and French by the publisher Haupt.
› WSL

Empa

A TRANSISTOR FROM THE PRINTER

"Printed electronics" is a growing scientific field in which transistors and other electronic components can be printed on any substrate. Empa has become a leading name in this area. The Coating Competence Center uses the latest printing techniques which enable completely new applications.

"The foreseeable need for printed electronics is huge," is how Jakob Heier assesses the situation, pictured here with Evgeniia Gilshtein (right) in Empa's Coating Competence Center (CCC).

At first glance, it sounds like a contradiction: printed electronics, such as transistors, electronic semiconductor components for controlling voltages and currents, which can be applied to any substrate by a printer. Can such a thing really exist? Absolutely! The world is eagerly awaiting such innovations, especially for the fast-growing Internet of Things, which has billions, even trillions, of interconnected sensors and devices. In order to produce such huge amounts, fast printing processes must be developed using roll-to-roll processing on flexible substrates such as polymers or paper.

Printed electronics is an extremely multidisciplinary field. Jakob Heier, for example, is a physicist, has a doctorate in materials science and engineering, worked for a time at a start-up on the development of electronic paper, and became involved in the formulation of inks and printing via polymer physics. In addition to leading his research group at the Empa Laboratory for Functional Polymers, he is currently also responsible for servicing the pressure systems required for printing electronics at the Coating Competence Center (CCC). Evgeniia Gilshtein, for her part, is a postdoc at the Empa Laboratory for Thin Films and Photovoltaics. A team from this laboratory had some time ago succeeded in printing electronic circuits and sensors from anorganic materials on polymer films. This breakthrough was made possible thanks to the "FOXIP" (Functional Oxides Printed on Polymers and Paper) project, which was financed by the ETH Domain's strategic research priority "Advanced Manufacturing". While it has been known for a long time how to print organic transistors, the Empa team, together with colleagues from EPFL and the PSI, attempted for the first time to print inorganic transistors, which not only promise higher performance, but are also significantly more stable. Inks made of oxide nanoparticles were used in this process. These are conductive inks that are transformed into printed electronics using highly specialised facilities in Empa's CCC. The tolerances during printing are within the micrometer range.

"Flash lamp annealing is the actual new breakthrough. In the blink of an eye, we can reach the necessary temperature in exactly the right place."

› Evgeniia Gilshtein, a researcher at the Empa Laboratory for Thin Films and Photovoltaics.

"The foreseeable need for printed electronics is huge," is how Heier assesses the situation, adding that "the more often thin sensors are also used to monitor physical conditions or on food packaging and other applications, the greater the demand will be." In 2020, a relevant report showed that this sector has now developed into a global market of more than 35 billion dollars a year. And the trend is set to continue strongly. A novel application of printed electronics for which Gilshtein is responsible is almost prototypically associated with this development.

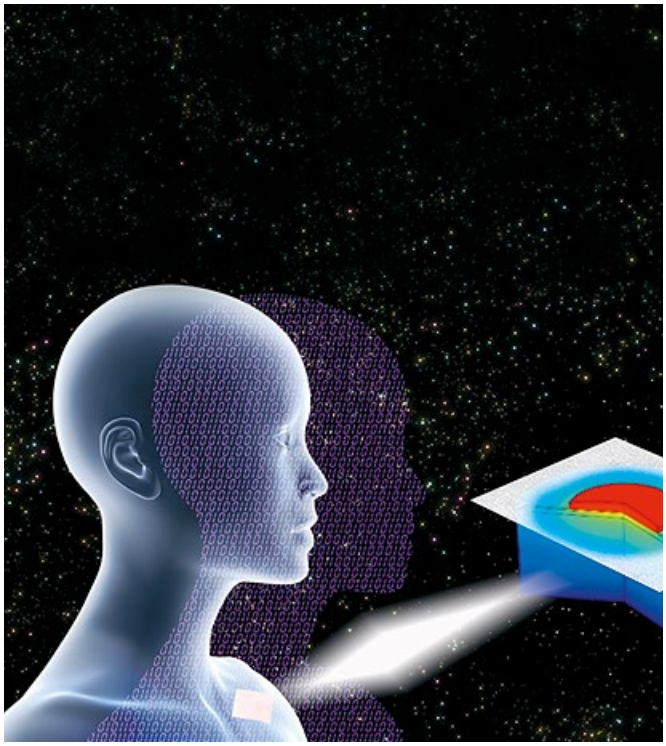
Using printed electronics, the Empa researcher has developed an invisible keypad where only authorised persons know how and where to enter the access code – the perfect camouflage for doors, lockers or even windows. Gilshtein was able to build on Empa's existing know-how relating to the printing of electronics on thin-film foils and to further develop this in a sophisticated way. First, the capacitive sensors were printed on the carrier foil, as has been done many times. Then, however, it was necessary to make the metal indium tin oxide-based nanoparticle ink more transparent and conductive than conventional substances. This was done using a trick: the patterns already printed on foils were dyed blue and "processed in a millisecond with a super-bright, energy-rich light source," said Gilshtein, adding that "the dye completely absorbs the incident light in the nanoparticles layer and makes it a homogeneous solid layer."

And as a certainly desired side effect, the blue dye decomposes during this process, and the electrically conductive indium tin oxide layer becomes optically transparent, i.e. invisible to the human eye.

The "secret ink" developed in this way is what made an invisible keypad for a safe possible in the first place. "Flash lamp annealing is the actual breakthrough. This means that we reach in exactly the right location in the blink of an eye, namely in the printed layer the required temperature of more than 500°C, in order to produce the electrically conductive material. The surface to be printed, i.e. paper or polymers, is hardly heated during this process," said Gilshtein.

However, the Empa researcher now wants to turn her attention to another scientific topic: stretchable printed electronics, ultra-thin sensors which will be applied directly to the human skin in a variety of forms. "Is this set to be the next big thing in printed electronics?"

The digital twin paves the way for personalised therapy



Thanks to digital twins, painkillers can be dosed on a patient-specific basis via the skin.
› Empa

Conventional therapies are often imprecise and poorly controllable, for example in the treatment of cancer patients' pain. Digital twins provide assistance: they enable precise dosing, which is tailored to individual patients, and a prediction of the course of therapy. Empa researchers have modelled several hundred such avatars on the basis of real people and treated them experimentally in collaboration with doctors. For the first time, the digital doppelgangers received feedback from the real patients, for example, about pain-free phases or pain intensity, thanks to which the therapy was further optimised. It showed that the optimal treatment programmes for women and men, as well as for younger and older people, were considerably different.

Biodegradable batteries made from wood

In the search for environmentally friendly, universally available materials for components used in energy production and energy storage, Empa researchers rely on an unusual material: wood. Or more precisely: nanocellulose, a component of the renewable raw material. Empa researchers have developed a compostable capacitor consisting of only cellulose, glycerol and saline, which can store electricity for hours and withstands thousands of charge and discharge cycles as well as years of storage, even at low temperatures. This capacitor works like a mini-battery resistant to pressure and shock loads. And when you don't need it anymore, you can throw it into the compost or just leave it outdoors in a natural environment; after two months, the battery will have decomposed into its basic components. In future, the biodegradable capacitor could become a key building block for the internet of things, which – for example, briefly charged via an electromagnetic field – supplies electricity for sensors and micro-transmitters.

The biodegradable battery on YouTube.

Smart energy management thanks to artificial intelligence

Making our energy future sustainable and renewable will also result in a significantly more volatile energy market in terms of supply and demand, and price. This is partly caused by the fluctuating amounts of solar and wind energy that is available. In addition, the energy system – even that of a single detached house – is becoming much more complex with heat pumps, solar heating systems and electric cars with battery packs. Artificial intelligence (AI) can help where energy management is concerned: Empa researchers have developed a self-learning AI control system that can learn from building data such as valve positions and room temperatures to adapt to rapidly changing external conditions. In addition, the level of comfort can be significantly increased whilst also reducing energy consumption by more than 25%, as realistic tests in the experimental building NEST showed. This technology is currently being launched by the Empa spin-off "viboo". And "Sympheny", another Empa spin-off, has recently started offering energy planners a web-based software that helps them develop optimal (cost-effective) efficient energy concepts for buildings, neighbourhoods or even entire cities.

EAWAG

NATURAL TOXINS: FROM THE ARSENAL OF A BACTERIUM

Cyanobacteria are ancient organisms. The most varied types of shells without a core, which, at high density in warm waters, can secrete complex substances and also toxins. Some are toxic to both humans and animals. Elisabeth Janssen is on the trail of these natural toxins: applied research, the results of which can be incorporated into water protection or water management.

During the warmer months, there are more and more headlines such as: "Are dogs still allowed to drink from the Greifensee?", "Blue algae have also spread in the Lake Constance region" or "Dogs have died from poisoning: swimming ban in Lake Neuchâtel." Often the lakes are then coloured blue-green or red. However, it is not by any means only algae that are responsible but also a large accumulation of so-called cyanobacteria, two billion-year-old organisms that can cause poisoning symptoms such as skin irritations or nausea in both humans and animals. A consequence of natural toxins (naturally present in the environment) that can produce cyanobacteria in warm waters. Elisabeth Janssen, who has a doctorate in environmental chemistry and works as the head of the "Environmental Chemistry of Biomolecules" research group at Eawag, is researching this phenomenon.

Ms Janssen, what are natural toxins? Everything can be toxic. Only the dose makes the poison. Naturally toxic initially only means that a substance has not been synthesised in a laboratory, but that it involves substances that come from nature and can be toxic to aquatic organisms and also to humans.

› Eawag researcher Elisabeth Janssen on the Greifensee for the purpose of taking water samples.

Why are you interested in cyanobacteria of all things? We are a water research institute, which is why we also deal with natural toxins in water. Cyanobacteria are fascinating because they produce a whole cocktail of interesting substances, some of which we know quite well and others not at all.

Are they all toxic? That is often not so clear. I therefore like to call them bioactive. Each of these substances has a specific function. They are the biochemical arsenal which the bacterium needs to survive and uses to keep enemies in check or to gain access to nutrients. Approximately 2,000 molecules of the different types of cyanobacteria are known to exist, some of which can be potentially toxic. Research on this is still pretty much in its infancy.

Cyanobacteria first appeared in research literature at the end of 18th century when scientists assumed that poisoning symptoms in animals could be related to toxicity stemming from these bacteria. Since the 1960s, when eutrophication in lakes increased significantly, more intensive research has been conducted on this topic. After dialysis patients in Brazil had ingested a deadly liver toxin via cyanobacteria in fresh water in the 1990s, researchers improved the data available on the responsible toxin to such an extent that the first molecule of these bacteria was included in WHO guidelines. This is a prerequisite for setting health impairment limits. Three other cyanobacteria molecules are now on the list.

In total, only four molecules are classified as toxic by the WHO. Are cyanobacteria harmless after all? No, they are not. It is just that it is difficult to establish a scientifically sound causal chain between the toxin responsible and a sick organism. Everyone who swims in a Swiss lake comes into contact with cyanobacteria. Whether a disease occurs depends on many different factors.

Namely? If a dog dies, a post mortem examination is conducted, and samples are taken from the lake and examined. However, everything is very complex and fleeting. In most cases, it is almost impossible to determine the exact density of bacteria since a body of water never behaves statically. How much water did the dog actually drink and did he or she have any pre-existing illnesses? It is extremely challenging to determine this precisely based on both epidemiological and scientific data.

What exact approach do you take? Most of the substances produced by cyanobacteria are not available for purchase, so we create laboratory cultures from bacteria that produce toxins, which are then isolated in the test tube. These act as a benchmark with which toxins from a body of water are compared. That is very challenging, even if it does not sound like it. For this to produce results, interdisciplinary expert opinions must be sought: for example, from ecologists, microbiologists, toxicologists or, like me, chemists. This is possible at Eawag.

What is the aim of this interdisciplinary scientific effort? I want to develop reliable chemical analytical methods for measuring toxins originating from cyanobacteria. We need to know what is inside the lake and how long-lived the substances are. This has a big impact on many things: on toxicity and on the question as to how we must manage bodies of water or water purification.

What role do humans have in this? Natural processes are strongly influenced by humans. The more we know about the toxins, the more we can also intervene in human-controlled interrelationships in order to better control cyanobacteria. In this respect, our team conducts basic research that can be applied in many areas.

Research that contributes towards achieving the SDGs

Long before the Sustainable Development Goals (SDGs) came into existence and sustainability became a hot topic, Eawag began pushing forward its research work in this area. The Department of Sanitation, Water and Solid Waste for Development (Sandec) develops and tests methods and technologies that enable the world's poorest people to achieve a sustainable water supply, waste management and sanitation. In this way, it focuses in particular on SDG number 6 "Ensure availability and sustainable management of water and sanitation for all." In its "Research & Capacity Development Projects and the Sustainable Development Goals" report, the Eawag department shows how and in which areas its research contributes to the achievement of the various SDGs. It is available on Eawag's website.

In a new report, Eawag shows how and in which areas its research contributes to achieving the various SDGs.
› Eawag

Click here to read the report.

Researchers: bridge-builders in Swiss water policy

Drinking water supply, hydropower or revitalisation of water bodies: the exchange of information between political players in these areas is important but not always easy. Scientific organisations are better suited to pass on information on water policy across political camps and thus to take on the role of bridge-builders. This is particularly true when different political positions between the players bring the flow of information to a halt. This was shown by an Eawag study in which about 400 political officials involved in Swiss water policy and its implementation were interviewed.

Standard practice: SARS-CoV-2 virus monitoring via waste water

The monitoring of SARS-CoV-2 virus quantities in waste water, which was jointly promoted by Eawag, EPFL and ETH Zurich, was extended from three to six large sewage treatment plants. Indirectly, this makes it possible to make statements about the spread or waning of the pandemic in over 1.2 million people. The virus material filtered from the waste water is regularly checked for mutations. In addition, the reproduction number (R_e) was successfully calculated from the waste water values. Now Eawag has developed a strategy for the Federal Office of Public Health and the cantons to transfer research into routine monitoring. The waste water from about 100 sewage treatment plants is to be sampled. This would cover around 70% of the population.

Sampling at the ARA Zurich-Werdhölzli sewage treatment plant.
› Andri Bryner/Eawag

In the area of drinking water supply, there is a need for communication between political actors.
› Gesa Lüchinger/Eawag

GOVERNANCE

Legal basis and structure of the ETH Domain

The Federal Government operates the Federal Institutes of Technology in accordance with the Federal Constitution (Art. 63*a* para. 1). As this is the law governing the ETH Domain, the ETH Act defines this mission. Together with Art. 64 para. 3 of the Federal Constitution, it also forms the legal foundation for operating the four research institutes of the ETH Domain and for the ETH Board as the strategic governing and supervisory body of the ETH Domain.

The Federal Act on the Federal Institutes of Technology of 4 October 1991 (ETH Act) defines the status, structure and mission of the ETH Domain. The ETH Domain is autonomous within the framework of the law. The ETH Act also defines the autonomy of the two Federal Institutes of Technology and the four research institutes. The ETH Domain has been allocated to the Federal Department of Economic Affairs, Education and Research (EAER) since 2013.

The partially revised ETH Act

The partially revised ETH Act entered into force on 1 November 2021. Firstly, it implements two Corporate Governance guidelines of the Federal Council (restriction of voting rights and recusal of institutional members of the ETH Board, Art. 25*a*). From the point of view of the ETH Board, it was thus possible to find a good solution which on the one hand guarantees the flow of information between the external and institutional members of the ETH Board, and on the other hand gives due consideration to the separation between the operational management level of the ETH Domain and the supervisory body (ETH Board) by ensuring that institutional members recuse themselves or have no voting rights in relation to certain items of business. A key aspect appears to be that – except in the case of recusal – all members of the ETH Board are still in the room and can express themselves, particularly also because decisions are generally made by consensus on the ETH Board. In addition, two recommendations of the Swiss Federal Audit Office (SFAO) regarding the general oversight competencies of the ETH Board will be implemented, provided that the SFAO's recommendations are supported by Parliament: For instance, the revised ETH Act stipulates how the ETH Board performs its supervisory role vis-à-vis the institutions (Art. 25 para. 4) and restricts the options of the institutions of the ETH Domain for appealing against certain decisions of the ETH Board (Art. 37 para. 2bis).

Further amendments relate to various minor changes to personnel law (specifically for employing professors after they have officially retired in justified exceptional cases and renewing fixed-term employment contracts for good cause) and creating the legal basis for selling surplus energy, for disciplinary measures and for security services and video surveillance.

Tasks

According to the purpose set out in Art. 2 of the ETH Act, both Federal Institutes of Technology and the four research institutes (institutions of the ETH Domain) must educate students and specialists in scientific and technical fields and ensure continuing education, expand scientific knowledge through research, foster the development of junior scientific staff, provide scientific and technical services, perform public relations work, and make use of their research results. The institutions of the ETH Domain discharge their mission in observance of internationally recognised standards. They take account of Switzerland's needs and promote international cooperation.

Strategic objectives and expenditure ceiling

The political leadership of the ETH Domain rests with the Federal Council and the Federal Parliament. The central leadership tools are the Dispatch on the Promotion of Education, Research and Innovation (ERI Dispatch) and the associated strategic objectives set by the Federal Council for the ETH Domain. The political tools are supplemented by the ETH Board's strategic controlling, which provides information on financial reporting and mission fulfilment.

Reporting

The ETH Board reports annually to the Federal Council and shows the degree to which the strategic objectives have been met and how the ETH Domain has used the total federal contribution. Based on the ETH Board's report, the Federal Council informs Parliament within the scope of its reporting. In each half of the Promo-

tion of Education, Research and Innovation Policy (ERI) period, the ETH Board compiles a self-evaluation report which comments on issues specified by the competent Federal Councillor, including on reaching the strategic objectives. This self-evaluation report serves as the basis for the evaluation of the ETH Domain by a group of international experts (peer review) which is to be carried out by the Federal Department of Economic Affairs, Education and Research (EAER).

Discussions are held twice a year between the proprietor, represented by the EAER and the Federal Department of Finance (FDF), and the ETH Board, represented by its President.

The managing and supervisory body ETH Board: Mission and operating principles

The ETH Board is responsible for the strategic leadership of the ETH Domain, it defines the strategy of the ETH Domain within the framework of the strategic objectives of the Federal Council, represents the ETH Domain when dealing with policy-makers and government authorities at federal level, issues directives about financial controlling, and carries out strategic controlling. It also approves the development plans of the institutions of the ETH Domain, oversees their implementation and supervises the ETH Domain (Art. 25 ETH Act). It agrees targets with the institutions and allocates federal funds, specifically on the basis of the institutions' budget requests (Art. 33*a* ETH Act). It submits requests to the Federal Council for the election or re-election of the Presidents of the two Federal Institutes of Technology and of the Directors of the four research institutes (Art. 28 para. 1 and 7 ETH Act). It also appoints the other members of the Executive Boards of the two Federal Institutes of Technology and of the Directorates of the four research institutes (Art. 28 para. 4 and 7 ETH Act). Finally, the ETH Board appoints professors at the request of the Presidents of both Federal Institutes of Technology (Art. 14 para. 2 and 3 ETH Act).

The Executive Boards of both Federal Institutes and the Directorates of the four research institutes are responsible for the operational leadership of the individual institutions of the ETH Domain. In accordance with Art. 4 para. 3 of the ETH Act, the institutions of the ETH Domain assume all responsibilities which are not expressly assigned to the ETH Board by the ETH Act.

The rules of procedure of the ETH Board are published in the compilation of Federal law. The ETH Board usually meets five times a year for two days at a time, and arranges additional meeting days for dialogues with the institutions of the ETH Domain. The President of the ETH Board is responsible for holding periodic individual discussions with the Presidents of the two Federal Institutes of Technology and with the Directors of the research institutes.

The ETH Board performs its supervisory function through the use of the following tools: periodic reporting by the institutions on resources (finances, personnel, real estate), annual reporting by the institu-

Structure of the ETH Domain

* employment contracts including doctoral students, as of: 31 December 2021

ETH Domain

ETH Board
11 members
57 employees (staff, Internal Audit, Internal Appeals Commission)

Federal Institutes of Technology

ETH Zurich
23,983 students and doctoral students
13,596 employees*

EPFL
12,127 students and doctoral students
6,377 employees*

Research institutions

PSI
2,130 employees*

WSL
579 employees*

Empa
1,012 employees*

Eawag
517 employees*

tions on the extent to which they have fulfilled their duties with regard to target agreements, annual discussions (known as dialogues) between the ETH Board and the institutions of the ETH Domain within the scope of strategic controlling, handling supervisory complaints addressed to it while observing subsidiarity and institutional autonomy, as well as reports by the institutions within the scope of their risk management systems. Moreover, the ETH Board's Internal Audit evaluates the risk management processes, internal control system (ICS) and governance processes of the institutions and report on them to the ETH Board.

Vested interests and awareness-raising activities
Corporate governance guideline 6 had the two following sentences added to it: "As a supplement to existing legal regulations, the Management or Institute Council issues a code of conduct on dealing with vested interests and ensures that suitable awareness-raising activities are performed. It provides information on the measures taken in the context of the Annual Report. The Management or Institute Council shall thus be obliged to issue a relevant code of conduct."

The level of regulation within the ETH Domain relating to vested interests is already very high today[1] (Art. 24*c* ETH Act; Art. 2*a* and 7*a* Ordinance on the ETH Domain: Art. 11, 13, 14 Management Salaries Ordinance; Guidelines of the ETH Board on secondary employment of members of the Executive Boards of the two Federal Institutes of Technology and of the Directorates of the research institutes; Guidelines of the ETH Board on secondary employment of professors in the ETH Domain; Art. 6 ETH Ordinance concerning Professors; Art. 56*a* Ordinance on the Personnel of the Federal Institutes of Technology for the ETH Domain (PVO-ETH); Guidelines of the two Federal Institutes of Technology on conflicts of interest and secondary employment (fully revised at the beginning of 2022). The legal requirements are consistently implemented by the ETH Board within its area of responsibility: All vested interests and secondary employment of members of the ETH Board and of members of the Executive Boards and Boards of Directors the ETH Domain's institutions are examined once a year by the Audit Committee and then approved by the ETH Board – subject to the proviso that the Federal Council is responsible – provided that the requirements are met in accordance with the applicable legal basis.

New vested interests and secondary employment shall be reported to the ETH Board during the year on an ongoing basis and examined to ensure compliance with the provisions of the Management Salaries Ordinance (no reputational risks or conflicts of interest; maximum workload of 10% of a full-time/part-time position as the case may be; surrender of the part of the income from secondary employment which exceeds 30% of the salary). In addition, the secondary employment of members of the ETH Board and the Directors of the research institutes is published on the websites of the Swiss Confederation[2] and the ETH Board[3]; the institutions are responsible for publishing the secondary employment of members of the Executive Board and of the institutions' Boards of Directors.

Audit and Executive Committee
The Audit Committee assists the ETH Board in financial supervision and in the monitoring of risk management, of the ICS and of financial auditing activities. As a rule, it is composed of two to three "external" ETH Board members who are independent of the executive leadership, but may also involve additional people in a consultative capacity. The President of the ETH Board, the head of the Internal Audit department and the head of the Finance section of the ETH Board's staff attend the meetings in an advisory capacity.

The Executive Committee assists the ETH Board in preparing for and following up on meetings, in filling management positions of institutions in the ETH Domain and in fulfilling its duties as an employer. It also liaises with the social partners. It is composed of the President of the ETH Board (chair), the Presidents of both Federal Institutes of Technology, the representative of the research institutes and the delegates of the University Assemblies. The Executive Director and, if necessary, other members of the ETH Board's staff attend the meetings.

Remuneration of the ETH Board
In January 2021, the President of the ETH Board received a gross salary of CHF 293,093 or 0.8 FTE (with an annual salary of CHF 366,366 or 1.0 FTE). In addition, the employer paid social security contributions of CHF 93,794. The President is insured by the Swiss Federal Pension Fund, the rules of which determine the employer contributions.

In 2021, the Vice President of the ETH Board, who also chaired the Audit Committee until the end of May and is not employed by any institution of the ETH Domain and is therefore called an "external member", received a lump sum of CHF 32,000. The new President of the Audit Committee, who is also an external member, received a total lump sum for the period from June to December of CHF 27,000 (on a pro rata basis). In 2021, the other four external members of the ETH Board each received a lump sum of CHF 20,000. In addition, they were paid a total of CHF 58,500 for dialogue meetings, the Election Preparation Committee and Audit Committee meetings (incl. pro rata lump sums amounting to a total of CHF 12,000 for chairing the Audit Committee for the corresponding audit of the annual financial statements). In addition, their expenses were refunded on the basis of the ETH Board Ordinance of 11 April 2002 concerning the reimbursement of expenses in the ETH Domain.

Those "institutional" members of the ETH Board who are employees of one of the institutions of the ETH Domain do not receive additional fees for their activities on the ETH Board. For the 0.7 FTE position, the ETH Board covered 40% of the wage and social security costs (including compensation for expenses) incurred by EPFL for the delegates of the University Assemblies of both Federal Institutes of Technology, in order to guarantee the delegates' independence from either institution.

[1] The relevant legal bases are published on the ETH Board website: www.ethboard.ch/legalbasis
[2] www.admin.ch/ch/d/cf/ko/Gremien_interessenbindung_79.html
[3] www.ethbaord.ch/vestedinterests

Management bodies of the ETH Domain

Presidency and Members of the ETH Board
- Prof. Dr Michael O. Hengartner [1], President
- Prof. Dr Dr h. c. Barbara Haering [2], Vice President (since January 2021), President of the Audit Committee (May 2019 to April 2021)
- Cornelia Ritz Bossicard [2], member (since January 2021), President of the Audit Committee (since June 2021)
- Prof. Dr Joël Mesot [1]
- Prof. Dr Martin Vetterli [1]
- Prof. Dr Gian-Luca Bona [1]
- Dr Kristin Becker van Slooten [1]
- Marc Bürki [2]
- Beatrice Fasana
- Prof. Dr sc. nat., Dr h. c. mult. Susan Gasser
- Christiane Leister

Executive Board of ETH Zurich
- Prof. Dr Joël Mesot, President
- Prof. Dr Sarah Springman, Rector (until January 2022)
- Prof. Dr Detlef Günther, Vice President for Research
- Dr Robert Perich, Vice President for Finance and Controlling
- Prof. Dr Vanessa Wood, Vice President for Knowledge Transfer and Corporate Relations (since January 2021)
- Prof. Dr Ulrich Weidmann, Vice President for Infrastructure
- Dr Julia Dannath-Schuh, Vice President for Personnel Development and Leadership

New member of the Executive Board of ETH Zurich
- Prof. Dr Günther Dissertori, Rector (from February 2022)

Executive Board of EPFL
- Prof. Dr Martin Vetterli, President
- Prof. Dr Jan Hesthaven, Vice President for Academic Matters (since January 2021)
- Dr Ursula Oesterle, Vice President for Innovation (since March 2021)
- Dr Matthias Gäumann, Vice President for Operations
- Françoise Bommensatt, Vice President for Finance (since June 2021)
- Prof. Dr Gisou van der Goot, Vice President for Responsible Transformation (since January 2021)

Directorate of the PSI
- Prof. Dr Christian Rüegg, Director
- Prof. Dr Gabriel Aeppli, Deputy Director
- Dr Thierry Strässle, Deputy Director
- Dr Peter Allenspach, Member
- Prof. Dr Andreas Pautz, Member
- Prof. Dr Gebhard F. X. Schertler, Member
- Prof. Dr Thomas J. Schmidt (since May 2021)
- Prof. Dr Mike Seidel (since May 2021)

Directorate of WSL
- Prof. Dr Beate Jessel, Director (since September 2021)
- Dr Christoph Hegg[3], Deputy Director, (Acting Director until August 2021)
- Prof. Dr Anna Hersperger, Member
- Prof. Dr Rolf Holderegger, Member, (Acting Deputy Director until August 2021)
- Prof. Dr Andreas Rigling, Member
- Prof. Dr Jürg Schweizer, Member

New member of the Directorate of WSL
- Birgit Ottmer, Member (since January 2022)

Directorate of Empa
- Prof. Dr Gian-Luca Bona, Director
- Dr Peter Richner, Deputy Director
- Dr Brigitte Buchmann, Member
- Dr Alex Dommann, Member
- Dr Pierangelo Gröning, Member
- Dr Urs Leemann, Member
- Dr Tanja Zimmermann, Member

Directorate of Eawag
- Prof. Dr Janet Hering, Director
- Prof. Dr Rik Eggen, Deputy Director
- Prof. Dr Jukka Jokela, Member
- Prof. Dr Tove Larsen, Member
- Gabriele Mayer, Member
- Prof. Dr Christian Zurbrügg, Member
- Prof. Dr Carsten Schubert, Member (since April 2021)

Appeals body

ETH Internal Appeals Commission
The ETH Internal Appeals Commission decides on appeals against rulings made by bodies of the institutions of the ETH Domain (Art. 37 para. 3 ETH Act). It is an independent internal appeals body with its registered office in Bern and is administratively assigned to the ETH Board, to which it reports (Art. 37*a* ETH Act). From 2022 onwards, the Federal Council will elect the members of the ETH Internal Appeals Commission. Appeals mainly relate to matters arising from legislation on human resources and higher education. Appeals against the rulings of the ETH Internal Appeals Commission can be made to the Federal Administrative Court.

- Lawyer Barbara Gmür Wenger, President
- Dr iur. Beatrix Schibli, Vice President
- Prof. Dr Simone Deparis, Member
- Jonas Philippe, Member
- Dr Dieter Ramseier, Member
- Prof. Thomas Vogel, Member
- Yolanda Schärli, Member

ETH Board support

Staff of the ETH Board
The ETH Board's staff support the ETH Board in fulfilling its legal mandate, particularly regarding strategic leadership, supervision, promotion of cooperation in the ETH Domain and liaising with the Federal authorities (Art. 26*b* ETH Act).

Executive Team
- Dr Michael Käppeli, Executive Director
- Dr Kurt Baltensperger, Head of Science
- Gian-Andri Casutt, Head of Communications
- Dr Dieter Künzli, Head of Finance and Personnel
- Dr Monique Weber-Mandrin, Head of Legal Services
- Michael Quetting, Head of Real Estate

Internal audit
The ETH Board employs Internal Audit staff, as per Art. 35*a*[ter] ETH Act.
It conducts the internal audits of the institutions of the ETH Domain.
- Patrick Graber, Head

[1] Member of the Executive Committee
[2] Member of the Audit Committee
[3] The Director of the WSL had a fatal accident on 8 August 2020 and Dr Christoph Hegg served as Acting Director of the WSL until the new Director took office in September 2021.

Status as at 31 December 2021
(reference is also made to changes agreed in 2021 which will become effective in 2022)

Ombuds Office

Ombuds Office
The Ombuds Office of the ETH Board (nyffenegger@mgnrecht.ch) is an independent body responsible in a subsidiary capacity for dealing with reports of illegal and unethical conduct observed by members of the ETH Domain in the course of ETH Domain-related activity. Subsidiary capacity means that, whenever possible, reports must initially be made inside the two Federal Institutes of Technology or the four research institutes, first to senior bodies or, if this is deemed unreasonable, to the bodies responsible for dealing with such reports in the institutions concerned.

This applies without prejudice to Art. 22*a* of the Federal Personnel Act (FPA): the employees are obliged to report all officially prosecutable crimes or offences which they have discovered during their official work or which have been reported to them, to the criminal prosecution authorities, their superiors or the Swiss Federal Audit Office (SFAO).

The ombudsman is:
- Dr Res Nyffenegger, external lawyer in Bern

Conciliation Commission

Conciliation Commission under the Gender Equality Act for the ETH Domain
The Conciliation Commission under the Gender Equality Act for the ETH Domain provides information and advice in the event of disputes which fall under the Gender Equality Act that involve employment relationships in the ETH Domain. The aim of the conciliation process is to achieve a mutually acceptable solution to the dispute in verbal negotiations with the parties (employer and employee) in order to avoid court proceedings. The Conciliation Commission does not issue any judgments. It handles cases confidentially, but not anonymously.

President's Office:
- Dr Anne-Catherine Hahn, President

Employer representative:
- Andreas Kirstein, ETH Zurich (member)
- Hélène Fueger, EPFL (member)
- Natalie Lerch-Pieper, PSI / Eawag (substitute member)
- David Heusser, Empa / WSL (substitute member)

Employee representative:
- Gregor Spuhler, ETH Zurich (member)
- Prof. Dr Sabine Süsstrunk, EPFL (member)
- Dr Rowena Crockett, Empa / WSL (substitute member)
- Dario Marty, PSI / Eawag (substitute member)

Monitoring and auditing

Internal control system
The institutions of the ETH Domain each have an ICS (Art. 35*a*[bis] ETH Act). It was introduced using the template provided by the Federal Government. Its objectives are to protect the assets of the ETH Domain, to prevent errors and irregularities in accounting, and to ensure proper accounting and reliable reporting. It is an integral part of the audit by the Swiss Federal Audit Office (SFAO) or the auditors appointed by it. The focus is on financially relevant business processes.

Internal audit
The Internal Audit department conducts internal audits for the institutions of the ETH Domain (Art. 35*a*[ter] para. 1 of the ETH Act). This department reports directly to the President of the ETH Board and its activities are supervised by the Audit Committee. The Internal Audit department provides independent, objectiveauditing services and supports the ETH Domain in achieving its aims. It is also responsible for coordinating and supporting the external audits of the ETH Domain.

Auditors
The SFAO performs external auditing duties for the ETH Domain (Art. 35*a*[ter] para. 3 ETH Act). In 2021, it audited the consolidated financial statements of both Federal Institutes of Technology, the consolidated financial statements of the ETH Domain and it conducted interim audits. The audits of the research institutes are performed jointly with PricewaterhouseCoopers (PwC). The SFAO's audit report on the consolidated financial statements of the ETH Domain comprises an audit report and a so-called "comprehensive report". These reports are discussed with representatives of the SFAO in the Audit Committee every year. In 2020, the SFAO invoiced the ETH Board for the total amount of CHF 566,289 (CHF 305,819 for the 2020 annual review and CHF 260,470 for the interim audit of the 2021 annual financial statements).

Information policy
Its legal mandate makes the ETH Board an interface between academia, policy-makers and society. Within its rules of procedure, the ETH Board undertakes to ensure honest, appropriate and transparent communication for the benefit of society and aims to explain its decisions and reinforce the role and reputation of the ETH Domain. Responsibility for this rests with the President. The key communication tools are the ETH Board's annual report to the Federal Government, the website www.ethboard.ch, targeted media relations work and the case-by-case illumination of relevant facts and positions, particularly regarding policies on education, research and innovation.

Participations and cooperations

In accordance with Article 3*a* of the ETH Act, the two Federal Institutes of Technology and the four research institutes may found or invest in companies, or cooperate with third parties in any other way within the framework of the strategic objectives and the ETH Board's directives, for the purpose of fulfilling their duties. The investments and relationships with controlled and associated entities are listed in sections 20 and 35 of the annual financial statements in the ETH Board's Annual Report and Financial Report respectively. These mainly involve investments in foundations and simple partnerships which meet accounting standards. The controlled entities Société du Quartier d'Innovation (SQIE) and Société du Quartier Nord de l'EPFL (SQNE), which maintain buildings on a finance lease basis with contracts over a lease term of 30 years, generate cash outflows therefrom of about CHF 9 million per year. The associated entities' have significant investments in the ETH Zurich Foundation. The contribution to the annual result of the ETH Domain amounted to CHF 25 million.

Michael O. Hengartner
* 1966, Swiss/Canadian
Prof. Dr

President of the ETH Board since February 2020.

Michael O. Hengartner served as President of the University of Zurich (UZH) from February 2014 to January 2020. From 2016 until his resignation as President of the UZH, he also served as President of swissuniversities. He also served as President of swissuniversities. Prof. Hengartner has dual Swiss and Canadian citizenship. He grew up in Quebec City where he studied biochemistry at the Université Laval. In 1994, he was awarded his doctorate at the Massachusetts Institute of Technology in the laboratory of Nobel Laureate H. Robert Horvitz. After that, he headed a research group at the Cold Spring Harbor Laboratory in the USA until 2001. In 2001, he was appointed to the newly established Ernst Hadorn Endowed Professorship at the Institute of Molecular Biology at the UZH. From 2009 to 2014, he was Dean of the Faculty of Science of the UZH.

Barbara Haering
* 1953, Swiss / Canadian
Prof. Dr sc. nat., Dr h. c. sc. pol.

Vice President of the ETH Board since 2021. Member of the ETH Board and of the Audit Committee since 2008. Member of the Executive Board and Chair of the Board of Directors of econcept AG.

Barbara Haering studied natural sciences and obtained a doctorate in spatial planning at ETH Zurich in 1996. She is a member of the Executive Board and Chair of the Board of Directors of econcept AG. In addition, she chairs the Conseil d'orientation stratégique at the University of Geneva and the Council of Foundation of the Geneva International Centre for Humanitarian Demining. Moreover, Prof. Haering is a member of the University Council of Dresden University of Technology and member of the Research and Technology Advisory Committee at Graz University of Technology. She is a lecturer at the University of Lausanne.

Joël Mesot
* 1964, Swiss
Prof. Dr sc. nat.

Member of the ETH Board and of the Executive Committee since 2010. President of ETH Zurich since 2019.

Joël Mesot studied physics at ETH Zurich, obtaining a doctorate in solid-state physics in 1992. He was awarded the ETH Zurich Latsis Prize in 2002 and the Swiss Physical Society (SPG) IBM Prize in 1995. After research residencies in France and the USA, he came to ETH Zurich and joined the PSI, where he became Head of the Laboratory for Neutron Scattering in 2004. He was director of the PSI from 2008 to 2018, and he has been a full professor of physics at ETH Zurich since 2008. Prof. Mesot is a member of various national and international advisory bodies, including the Foundation Board of the "Switzerland Innovation" Park, the Marcel Benoist Foundation, the Global Network Advisory Board of the World Economic Forum (WEF) and the Governing Board CREATE (Singapore). › Markus Bertschi / ETH Zurich

Marc Bürki
* 1961, Swiss
Dipl. El.-Ing.

Member of the ETH Board since 2017 and of the Audit Committee since 2018. CEO of Swissquote Group Holding Ltd since 1999 and of Swissquote Bank Ltd since 2002.

Marc Bürki obtained a degree in Electrical Engineering from EPFL. After gaining his initial professional experience with the European Space Agency in the Netherlands, he formed Marvel Communications S.A. in Gland in 1990, a company that specialised in the development of financial information software. Swissquote Group Holding Ltd, which specialises in online trading, was formed in 1999 and was floated on the stock market in 2000. In 2001, Swissquote Bank Ltd received a banking licence. M. Bürki is the CEO of both companies. Furthermore, he is President of the Board of Directors of Swissquote MEA Ltd, Dubai, UAE (since 2012), of Swissquote Ltd, London, UK and of Swissquote Asia Ltd, Hong Kong, (both since 2014), of Swissquote Pte. Ltd, Singapore and of Swissquote Bank Europe SA, Luxembourg (both since 2019) and since 2021 President of the Board of Director of YUH Ltd, a joint venture between Swissquote and PostFinance.
› Swissquote

Beatrice Fasana
* 1969, Swiss/US citizen
Dipl. Ing. Lm

Member of the ETH Board since 2012.
Managing Director at Sandro Vanini SA since 2013.

Beatrice Fasana studied Food Science at ETH Zurich. After a traineeship at the "Nestlé Research and Development Center" in New Milford (Connecticut, USA), she worked in various leadership roles for several large food and beverage production companies in Switzerland, including manager of Chocolat Frey's "Chewing Gum" Profit Center and as a marketing manager for Coca-Cola. Until the end of 2012, she ran her own company BeFood Consulting SA. Since 2013 she has held the position of Managing Director at Sandro Vanini SA, a company of the Haecky Group. B. Fasana is also a member of the Board and Chair of the Management Committee of the University of Applied Sciences and Arts of Southern Switzerland (SUPSI, Scuola universitaria professionale della Svizzera italiana) and has been a member of the Board of Directors of Raiffeisen Bank del Basso Mendrisiotto since 2018.

Susan Gasser
* 1955, Swiss
Prof. Dr sc. nat., Dr h. c. mult.

Member of the ETH Board since 2018. Director of the ISREC Foundation at the AGORA Research Centre since February 2021. Professor of Molecular Biology at the University of Basel from 2005 to 2021, visiting professor at the University of Lausanne since 2021.

Susan Gasser studied biology and biophysics at the University of Chicago and obtained a doctorate at the University of Basel. She was group leader at the Swiss Institute for Experimental Cancer Research (ISREC) from 1986 until she was appointed full professor at the University of Geneva in 2001. From 2004 until 2019, she was Director of the Friedrich Miescher Institute for Biomedical Research (FMI) in Basel. She was also a full professor of Molecular Biology at the University of Basel from 2005 and since 2021, she has been a visiting professor at the University of Lausanne. Since February 2021, she has been the Director of the ISREC Foundation at the AGORA Research Centre. Prof. Gasser is the Chair of the scientific advisory board of the Helmholtz Association health centres (research area: health), a member of the scientific advisory board of the Francis Crick Institute in London and a member of the European Molecular Biology Laboratory (EMBL) in Heidelberg. From 2014 to 2019, she chaired the Gender Equality Commission of the Swiss National Science Foundation (SNSF). › Nestlé Nutrition Council

Martin Vetterli
* 1957, Swiss
Prof. Dr sc.

Member of the ETH Board and of the Executive Committee since 2017. President of EPFL since 2017.

Martin Vetterli received his degree in Electrical Engineering from ETH Zurich, before then completing his Master's in Science at Stanford University and finally obtaining his doctorate at EPFL. Following professorships at Columbia University and at the University of California, Berkeley, he returned to EPFL as full professor of Communication Systems in 1995. From 2000 to 2003, Prof. Vetterli was a member of the Swiss Science Council (SSC). From 2004 to 2011, professor Vetterli was Vice President of EPFL, and he was Dean of the School of Computer and Communication Sciences at EPFL from 2011 to 2012. From 2013 until the end of 2016, he was President of the National Research Council of the Swiss National Science Foundation (SNSF).
› Nik Hunger/EPFL

Gian-Luca Bona
* 1957, Swiss
Prof. Dr sc. nat.

Member of the ETH Board since 2019. Representative of the research institutes on the ETH Board. CEO of Empa and dual professor at ETH Zurich/EPFL since 2009.

Gian-Luca Bona studied physics at ETH Zurich, where he completed his doctorate in 1987. He then began his career at IBM, first at the IBM Research Centre in Zurich and later in the USA, where he led the Science & Technology department at the IBM Almaden Research Center in San Jose from 2004 to 2008. He was director of Tape Storage Solutions at IBM in Tucson, from 2008 to 2009, where he was responsible for the research and development of magnetic tape storage products. Prof. Bona's roles include being a member of the Foundation Board of the Technopark Zurich and of the Board of Trustees of the Innovation Park Zurich. He is a member of the Board of Directors of Innovation Park Ost, of Comet Group Ltd and Bobst Group Ltd, and of the Advisory Council of the Federal Institute for Materials Research and Testing (BAM) in Berlin. › Empa

Kristin Becker van Slooten
* 1962, Swiss/German
Dr

Member of the ETH Board and of the Executive Committee since 2017. Representative of the university assemblies of ETH Zurich / EPFL on the ETH Board. Project head of equal opportunities at EPFL since 2017. Maître d'enseignement et de recherche (MER).

The environmental scientist Kristin Becker van Slooten studied Biology at the University of Geneva and obtained her doctorate in Environmental Chemistry and Ecotoxicology at EPFL. From 1995 to 2002, she was employed as a scientist at the Laboratory for Environmental Chemistry and Ecotoxicology, where she headed up the Experimental Ecotoxicology research group from 2002, obtaining the title of MER in 2005. From 2006 to 2016, she was an advisor to the President and General Secretary of EPFL. K. Becker van Slooten has been the project manager for equal opportunities at EPFL since 2017 and has reprised her role as a delegate on the ETH Board, representing the university assemblies of ETH Zurich and of EPFL as she did from 2004 to 2006.

Christiane Leister
* 1955, Swiss/German
Graduate economist (Dipl.-Vw.)

Member of the ETH Board since 2017. Owner and President of the Board of Directors of the Leister Group since 1993.

After graduating from Christian Albrecht University of Kiel with a degree in Economics, Christiane Leister started her career at Jungheinrich (floor-level conveyors and warehousing systems). She then headed the Controlling and Finance departments of Vereinigte Papierwerke AG and Milupa AG. She took over strategic and operational duties within the Leister family business in 1989. She has been the owner of the Leister companies since 1993, where she also acted as operations manager until 2014. During that time, Ch. Leister diversified the companies with new technologies and expanded them internationally to create the Leister Group.
› Leister Ltd

Cornelia Ritz Bossicard
* 1972, Swiss)
Business economist, graduate auditor

Member of the ETH Board and of the Audit Committee since Member of the ETH Board and of the Audit Committee since 2021, President of the Audit Committee since May 2021. Independent board member.

Cornelia Ritz Bossicard studied Business Administration at HEC Lausanne and the Freie Universität Berlin and obtained a Master of Science in Business Administration. In addition, she is qualified as both a Swiss Certified Accountant and a US Certified Public Accountant. From 1995 to 2004, she worked as an auditor and senior advisor with PwC, both in Switzerland and the Silicon Valley, USA. Since 2014, she has been a sparring partner for strategy, corporate governance and finance and served on a variety of Boards of multinational companies as an independent board member. She is the founder of 2bridge Ltd and, among other things, a member of the administration of the Federation of Migros Cooperatives and of the Board of Directors of Läderach, as well as President of swissVR and the César Ritz Foundation Niederwald. Having chaired various audit committees for many years, Cornelia Ritz Bossicard is a recognised expert in financial supervision.
› Cornelia Ritz Bossicard

A complete overview of the vested interests of the members of the ETH Board can be found at www.ethboard.ch/vestedinterests.

Personnel matters

Personnel matters of the Federal Council

On 12 May 2021, the Federal Council confirmed the appointment of Empa CEO, Prof. Dr Gian-Luca Bona. He was re-elected for a fourth term from 1 September 2021 to 31 May 2022 until he reaches retirement age in May 2022. Under the leadership of Prof. Bona since 2009, Empa has developed into an internationally leading research institute for materials research and innovative technologies with more than 1,000 employees. The ETH Board initiated the succession plan in May 2021 and expects the process to be completed in the spring of 2022.

On 4 June 2021, the Federal Council elected Prof. Dr Beate Jessel as the new Director of WSL. She took up her position on 1 September 2021. Previously, since 2007, she had been the President of the Federal Agency for Nature Conservation (BfN) in Bonn. Prof. Jessel studied landscape conservation at the Technical University of Munich (TU Munich) where she also obtained a doctorate. From 1999 to 2006, she held a professorship in landscape planning at the Institute of Geoecology at the University of Potsdam, and from 2006 onwards, she held the Chair of Strategy and Management of Landscape Development at TU Munich. Her position as Director of WSL is associated with a professorship at ETH Zurich and EPFL.

Preparations for electing the successor to the Eawag Director
The Director of Eawag, Prof. Dr Janet Hering, who has been in office since 2007, is retiring as of 31 December 2022. To fill the position, the ETH Board initiated the election preparation process. The position was advertised at the end of 2021, both nationally and internationally.

Personnel matters of the ETH Board

Appointments to the Executive Board of ETH Zurich
At the request of the President of ETH Zurich, Joël Mesot, the ETH Board appointed Prof. Dr Günther Dissertori as the new Rector of ETH Zurich. He will be the successor to Prof. Dr Sarah Springman, who is retiring as of 31 January 2022. As Rector and Vice President, Prof. Dr Dissertori is responsible for teaching issues on the Executive Board of ETH Zurich. From 2001 onwards, he was associate professor at ETH Zurich, and in June 2007, he was appointed full professor at the Institute for Particle Physics. He has in-depth knowledge of the design and review of courses of study and is known for his extraordinary commitment to teaching.

Appointments to the Executive Board of EPFL
At the request of EPFL President, Martin Vetterli, the ETH Board appointed Françoise Bommensatt as the new Vice President for Finance for the period from 2021 to 2024. Bommensatt has an impressive amount of experience in managing finance departments in the higher education sector, including as Chief Financial Officer at the Swiss Education Group, a business and hospitality management institution based in Montreux. She previously worked as Executive Managing Director at the Collège du Léman and as Finance Manager at CERN. Bommensatt holds a Master's degree in Business Administration and Quantitative Analysis from the Université Louis Pasteur in Strasbourg, France. She took up her new position in June 2021.

For the first time in the history of EPFL, the Executive Board consists of 50% women.

New member of WSL Management
At the request of Prof. Beate Jessel, Director of WSL, the ETH Board will appoint Birgit Ottmer, Head of Communications at WSL, as a new member of WSL Management as of the beginning of January 2022. Ottmer studied environmental sciences at ETH Zurich and has been working for WSL in various roles since 2001. She has been Head of Communications at WSL since 2009 and is a proven expert in science communication.

Professorial matters
Refer to page 47 for information about the appointment of professors.

Professorial matters

Appointment of professors
In 2021, the ETH Board dealt with 156 professorial matters at its meetings. It appointed a total of 85 professors, 52 of whom were newly appointed members of staff and 33 were internal promotions. At ETH Zurich 16 women and 25 men were appointed, and 19 women and 24 men were appointed at EPFL. In addition, there is the new Director of WSL who was appointed full professor at both ETH Zurich and EPFL.

Out of the 27 full professor appointments, 16 involved promotions of associate professors, and one was a promotion of an assistant professor with tenure track. 16 of the 24 associate professor appointments were promotions of assistant professors with tenure track.

Women accounted for 24 (46.2%) of the 52 newly appointed professors in 2021. Over the past four years, the average proportion of women among newly appointed professors has been 36.9%.

In addition, the ETH Board awarded the title of professor (adjunct professor) to 10 scientists.

Retirements and resignations
In 2021, the ETH Board was informed of 21 retirements: 12 from ETH Zurich, 8 from EPFL and the retirement of the Director of Eawag, who is and will be a full professor at both ETH Zurich and EPFL until 31 December 2022. In addition, ETH Zurich and EPFL advised the ETH Board of a total of 9 resignations for other reasons.

Appointments

85

Professors, 16 of whom were women and 25 men at ETH Zurich, as well as 19 women and 24 men at EPFL and 1 woman at both ETH Zurich and EPFL

Proportion of women

46.2%

of newly appointed persons

The total of 85 appointments comprised:

Full professorships*	Associate professorships	Assistant professorships with tenure track	Assistant professorships without tenure track
27	24	30	4
13 of whom were women	3 of whom were women	17 of whom were women	3 of whom were women

Risk situation and risk management

As the managing and supervisory body, the ETH Board sets out the risk policy for the ETH Domain. In this capacity, it has set various objectives for the six institutions. On the one hand, this serves to ensure that the tasks are performed effectively, cost-efficiently and with foresight, and that functional and innovative capability are maintained. On the other hand, this should guarantee personal safety and the security of property and other assets to the greatest possible extent. The leadership of the institutions is intended to be supported by comprehensive, transparent and up-to-date risk information, risk awareness should be promoted among students and staff, and the good reputation of the ETH Domain is to be safeguarded.

All the institutions of the ETH Domain have their own procedures for risk management, which serve to identify and evaluate the individual risks, as well as strategies for coping with them and for monitoring them appropriately. The risk management activities and supervision of risk management procedures are coordinated in each institution by a risk manager and/or a risk committee. Each institution keeps its own risk catalogue in which the identified risks are described in detail with an assessment on the basis of probability of occurrence and extent of the potential damage. This risk catalogue is updated at least once a year. In addition, consideration is given to the possible effect a risk could have on reputation. The individual profile, specific focus and size of each institution are reflected in its risk catalogue. Thus, the two Federal Institutes of Technology have different core risks to the four research institutes, and the assessment of the same risks can vary.

As part of their annual reporting to the ETH Board, the institutions provide information about their core risks, in particular their current status, extent and possible consequences. Core risks are those risks with potentially significant financial consequences and that have an above-average probability of occurring. They directly endanger the fulfilment of the institutions' legal duties. The reports on the core risks are then submitted to the department responsible for the ETH Domain. Moreover, the ETH Board must be informed directly by the institutions about any extraordinary changes in risk or damaging events.

The effects of an inhibiting political and legal environment – in particular the non-association of Switzerland in Horizon Europe – as well as the uncertainty in terms of funding developments are two of the greatest risks faced by the ETH Domain. The coronavirus pandemic was a major issue faced by the institutions of the ETH Domain again in 2021. The risk of a pandemic, which was reassessed based on previous experiences, is still classified as a core risk. Other major core risks of the ETH Domain are associated with violence/threats against people, the loss of key personnel, cyberattacks, infringements of scientific integrity and good academic practice, taking on excessive obligations and the risk of a lack of oversight of long-term financial obligations and the consequences of such, as well as the loss of management and control due to the creation of external structures.

Despite careful risk management, it cannot be ruled out that an institution may be affected by a damaging event which endangers the fulfilment of its duties enshrined in law. In this case, the ETH Board would submit a request to the Federal Department of Economic Affairs, Education and Research (EAER), for the attention of the Federal Council, to adapt the strategic goals or increase the federal financial contribution in accordance with Art. 30 para. 2 of the Ordinance on Finance and Accounting of the ETH Domain following consultation with the Federal Finance Administration (FFA).

The insurance policies taken out by the institutions are of great importance. The institutions must take out insurance against possible losses, subsidiary to other measures, where such insurance is feasible and the funding is sufficient for it. Each institution is responsible for taking out insurance cover and administering its own insurance portfolio. When doing this, they have to take into account their specific risk situation, strive for an appropriate cost/benefit ratio and ensure compliance with the federal regulations governing public sector procurement. The insurance cover must meet the standards which are customary in the Swiss insurance market and be concluded with an insurance institution that is licensed in Switzerland. The institutions have taken out property and employers' liability insurance policies, as well as smaller insurance policies for specific risks. The real estate owned by the Federal Government is not insured, because the Confederation follows a strategy of self-insurance.

STRATEGIC OBJECTIVES

Details of the Federal Council's strategic objectives for the ETH Domain can be found on the SERI website www.sbfi.admin.ch under Higher Education/ETH Domain.

Strategic objective

TEACHING

In 2021, 36,110 students and doctoral students were enrolled at ETH Zurich and EPFL. The reopening of the campus and the partial easing of pandemic-related restrictions led to innovations in teaching. In particular, new hybrid forms of teaching have been introduced, combining online and face-to-face courses.

Excellence in research and competence-oriented education

The courses of study offered by the institutions in the ETH Domain are considered to be extremely attractive, both in Switzerland and abroad. In 2021, 23,983 students and doctoral students were enrolled at ETH Zurich and 12,127 at EPFL. Since 2021, these figures no longer include exchange students, which has to be taken into account when comparing them with those from previous years. The proportion of women at Bachelor's and Master's level increased further (2021: 31.6%, 2020: 31.3%), this also occurred at doctoral level (2021: 33.9%, 2020: 33.6%). The proportion of foreign students and doctoral students also increased (2021: 48.1%, 2020: 47.7%). Their proportion is significantly higher at doctoral level than at Bachelor's level and Master's level (see Fig. 9, p. 95).

The two Federal Institutes of Technology are continuously developing their study programmes with a view towards reflecting the needs of society. For example, EPFL expanded its offering in the field of sustainability and launched a new Master of Science in Sustainable Management and Technology in collaboration with the University of Lausanne and IMD (International Institute for Management Development in Lausanne). From the 2021–2022 academic year onwards, EPFL's Environmental Sciences and Engineering programme will also offer Sustainability as a minor. In addition, two new Master's degree programmes in Neuroengineering and Statistics were approved in the autumn of 2021. They will be offered from the 2022–2023 academic year. A Master's degree in Quantum Science and Engineering is also in the approval phase and can start from the autumn of 2022. In the reporting period, the first students at ETH Zurich started their studies in the new Master's degree programme in Landscape Architecture. At a structural level, the EPFL launched working groups to work out a roadmap for the development of the Bachelor-Master cycle. Amongst other things, they focused on questions about teaching in the first year, on project work and hybrid teaching. At ETH Zurich, several important ordinances were fundamentally revised. One important milestone was, amongst other things, the revision of the Ordinance on the Doctorate, which improved the conditions for the support and personal development of doctoral students and introduced early detection measures in the event of problems.

ETH Zurich founded a new doctorate school in the field of "Materials and Processes" for doctoral students. This is now the third doctorate school to be part of the Department of Materials, and includes people from eleven departments. The two Federal Institutes of Technology launched their first joint doctoral programme in Learning Science in 2021. This new programme focuses on the research of learning processes and new educational approaches.

The research institutes also actively contribute to the outstanding education in the ETH Domain by offering

courses, seminars, practical work and other educational opportunities in various disciplines. In 2021, their commitment included a total of 19,305 teaching hours at national or foreign universities (2020: 18,553, see Fig. 12, p. 96). In the reporting period, more than a dozen scientists from the research institutes were appointed as professors (including titular professorships) at one of the two Federal Institutes of Technology or another Swiss university. In addition, the research institutes helped to supervise 736 Bachelor's and Master's theses and 872 doctoral theses.

Encouraging interdisciplinary competencies

The institutions of the ETH Domain promote the development of interdisciplinary competencies with the aim of enabling graduates to deal with complex and multifaceted problems and thus to make a responsible contribution to the future of society. In addition to teaching methodology-specific and thematic competencies, the ETH Domain attaches particular importance to the development of critical and self-critical thinking. To that end, it promotes, amongst other things, dialogue and cooperation with the humanities and social sciences. ETH Zurich's Critical Thinking Initiative gives students the opportunity to acquire methodological-specific, social and personal skills. It also ensures that more attention is paid to critical thinking at the university through the organisation of conferences and workshops or the dissemination of publications. In the reporting period, Critical Thinking stabilised its links to other initiatives. One is the PRISMA student project, which aims to integrate new perspectives on how science and technology can contribute to solving social problems into the programme of existing courses.

In order to promote openness and interdisciplinary competencies, ETH Zurich adapted its catalogue of courses to raise students' awareness of courses that support the development of interdisciplinary competencies and whose content focuses on the United Nations Sustainable Development Goals. The MyPath portal was also launched so that students can actively integrate the extra-curricular activities and initiatives offered at ETH Zurich into their time of study. The portal enables students to search precisely for offers for obtaining interdisciplinary competencies in all degree levels. The EPFL catalogue of courses in the humanities and social sciences is also currently being revised. At the same time, EPFL is creating a framework for coordinating and consolidating current and future teaching of interdisciplinary competencies, mainly in the Bachelor's and doctorate degree programmes. Since 2021, EPFL has been offering a new Communication in Science and Technology course at doctoral level. The theory and skills necessary for the dissemination of scientific findings are taught by a group of experts with practical experience, especially from the media sector. The research institutes also promote dialogue with the humanities and social sciences. A particularly important aspect is the interface between economics, politics and science. For example, WSL offers a course at ETH Zurich on the topic of ecological economics. It enables an interpretation of the current prevailing economic policy discourse against the background of the numerous crises that our society is

ETH Zurich is expanding its teaching and research activities in quantum sciences and has developed the novel Master's degree programme in Quantum Engineering. The picture shows the lab of Andreas Wallraff, Professor of Solid State Physics (see also p. 15).

facing. At the University of Bern, Eawag offers two courses on solving environmental conflicts and shaping public policy to solve major societal challenges.

The promotion of interdisciplinary approaches is also of crucial importance for the development of interdisciplinary competencies. EPFL continues its investments in interdisciplinary projects within the framework of MAKE, a programme to support interdisciplinary projects. Numerous laboratories from all institutes participate in MAKE. In the 2020–2021 academic year, the students showed great interest in this form of project-based teaching. Two examples of successful MAKE projects are the EPFL Rocket Team, which was crowned European Champion in the EuRoC 2021 rocket competition, and the Xplore team, which won the bronze medal for its space robot during the European Rover Challenge. In addition to these activities, which are integrated into the curriculum, the students were able to carry out their own projects within the framework of specific associations. In this respect, they benefited from the MAKE infrastructure and received the appropriate support. With its Student Project House initiative, ETH Zurich offers a space for reflection and creativity that promotes the exchange of ideas between students from all disciplines. In 2021, in addition to the existing location on the Hönggerberg campus, a second one was opened near the main building of ETH Zurich. The number of student projects has thus increased significantly (see p. 18).

In 2021, ETH Zurich launched an important project for the development of teaching in order to strengthen computer skills in all Bachelor's and Master's degree programmes. The team responsible for the project developed a competence framework in consultation with the persons responsible for the various study programmes. This framework reflects the current requirements of several occupational fields. The latter should have been acquired by the students in the relevant fields of study at the end of their studies. EPFL expanded its range of digital courses at Bachelor's and Master's level to include specific courses, depending on the field of study. Advanced courses are also offered for Bachelor's students who want to deepen their knowledge of artificial intelligence and machine learning.

Innovations and quality assurance in teaching

With the advent of new technologies and the increasing digitalisation of society, the institutions of the ETH Domain are gradually introducing innovations in teaching. In the reporting period, ETH Zurich financed, for example, several educational innovation projects from the Innovedum Fund, including the "Computer-based Virtual Environment Simulations for Differential Diagnosis in Medical Education" project. The project contributes overcoming one of the fundamental challenges of medical education: ensuring the best-possible transfer of knowledge and skills into clinical practice. The coronavirus pandemic has revealed how important the investments of the institutions of the ETH Domain in new forms of teaching are and has accelerated their consolidation. In the various phases of the pandemic, teaching had to be continuously adapted. In the spring semester of 2021, classes were mainly conducted online, whereas in the autumn semester, face-to-face learning was largely possible. For students who could not get on campus, the two Federal Institutes of Technology provided video recordings of the courses and conducted hybrid courses. EPFL created an extensive collection of video resources that were automatically indexed with keywords and are easily accessible to the university community.

The number of courses in the form of flipped classrooms is also steadily increasing. In the 2021–2022 academic year, around 20% of basic courses at EPFL are held in this form. Back in 2018, there were only two flipped classrooms. The use of Jupyter Notebooks – interactive, versatile and flexible documents – by students is also increasing. At ETH Zurich, the teaching staff exchange experiences and best practices relating to new forms of teaching at lunchtime Refresh Teaching events organised by the Department of Teaching Development and Technology. The research institutes also contributed to innovations in teaching. Two online PSI courses received the Comenius EduMedia seal, which honours exemplary educational media. With the support of an expert from the Canton of Aargau, several WSL employees created a virtual excursion, during which ETH Zurich students could explore four locations along an important Swiss wild animal corridor. In cooperation with the existing solution at ETH Zurich, Empa set up an online learning platform (Moodle).

The two Federal Institutes of Technology establish and use different tools to ensure continuous excellence in their courses of study. At institutional level, ETH Zurich was awarded unconditional accreditation by the Swiss Accreditation Council in 2021 following an assessment procedure by the Swiss Agency of Accreditation and Quality Assurance (AAQ). EPFL initiated the corresponding procedure at the beginning of 2021. Institutional accreditation guarantees compliance with quality assurance criteria at national and international level. In the reporting period, ETH Zurich also developed a tool for quantifying teaching activities at the level of professorships. It should ensure greater transparency and better use of teaching resources. EPFL set up a new Propaedeutic Center to facilitate the organisation and running of the major courses in the first year of study, and in particular the corresponding exercise sessions. The new Learning Companion digital tool, introduced by EPFL in 2020 to help students develop efficient learning methods, has seen an increase in the number of users of the application. The Special Mathematics Course (CMS) at EPFL enables students who do not have the necessary qualifications to enter the first year of a Bachelor's degree programme to consolidate their skills relating to basic scientific principles before they start their studies. Since 2020, the CMS has also been open to holders of an academic baccalaureate on a voluntary basis. In 2021, interest in this programme increased further. This shows that there is a real need for it.

The two Federal Institutes of Technology regularly conduct surveys among students in order to evaluate their overall satisfaction and the quality of teaching. In the reporting period, the pandemic still had a significant impact on the morale of the student community. At ETH Zurich, only 62% of those surveyed in the spring of 2021 said they were satisfied or very satisfied overall with their situation (compared to 82% in the last survey in 2015). This was mainly due to a lack of interaction and general decrease in motivation. At EPFL, this pandemic-related lack of interaction also led to a slight decrease in satisfaction with some courses, especially with laboratory internships. However, this dissatisfaction was offset by a higher level of satisfaction with other courses. The two Federal Institutes of Technology are following the results of the evaluations carefully and reacting with appropriate measures.

Promotion of national and international mobility

The institutions of the ETH Domain promote the national and international mobility of students in order to promote the exchange of experiences and ideas as well as the acquisition of language skills. However, student mobility was still affected by the coronavirus pandemic in the reporting period. In the 2020–2021 academic year, exchanges with institutions outside of Europe were completely suspended. Even in 2021–2022, many universities are only open to foreign students to a limited extent. The aim of the two Federal Institutes of Technology is, in line with the new regulations of Movetia, the national agency for the promotion of exchange and mobility between Switzerland and Europe, to strike an appropriate balance between the number of students coming to Switzerland and going abroad as part of new and existing partnerships. To that end, ETH Zurich extended its mobility programmes to motivate more students to study at a foreign university. EPFL has decided to renegotiate or terminate certain agreements with European partners, in order to limit exchanges in the context of very unbalanced partnerships or to increase them for highly sought-after destinations (see also Fig. 11, p. 96).

At the national level, the two Federal Institutes of Technology once again managed to organise joint summer schools.

Further education

Further education is an effective tool for the transfer of knowledge and technology between scientists and society. In 2021, the institutions of the ETH Domain once gain expanded their further education programme, in order to meet the needs of society and the labour market in the best possible way. For example, in 2021, ETH Zurich expanded its further education offer to include several new programmes, such as a new Master of Advanced Studies (MAS) in International Governance and Law together with the UZH. The programme is aimed at managers and professionals from public administration. They learn about how international bodies and institutions function and operate, in order to be able to represent their interests to external stakeholders in a targeted and efficient manner. The two Federal Institutes of Technology also introduced a new MAS in Urban and Territorial Design. Through this programme, both institutes can offer an innovative programme for the development of solutions for current business and ecological challenges. On the part of the research institutes, the PSI organised the international virtual Hercules School on Neutron and Synchrotron Radiation in collaboration with the European Synchrotron Radiation Facility (ESRF) and the Institut Laue-Langevin (ILL) in Grenoble. As part of this one-month further education programme, young scientists participated in virtual courses, visits and practical distance working at the SLS beamlines and in the PSI's SINQ experimental stations. WSL strongly expressed its support for the new Certificate of Advanced Studies (CAS) of ETH Zurich in Natural Hazard – Risk Management, which was offered for the first time in 2021. Empa also offered several continuing and further education courses, including a virtual course on the introduction to non-destructive analysis by means of X-ray imaging and basic and further education courses in the field of 3D metal printing for medical devices for apprentices, experts and decision-makers at the Swiss m4m Center for Additive Manufacturing (see also Objective 4, p. 65). Eawag's practical further education programme, PEAK, offered various courses, which were mostly conducted in hybrid or purely virtual formats. The courses were held in several languages, in order to open them to a wider audience.

Strategy to develop the number of students and doctoral students

The institutions of the ETH Domain are developing a joint strategy to guarantee excellence in teaching, even with a significant increase in students and doctoral students. To that end, a working group composed of representatives of the two Federal Institutes of Technology and the research institutes was set up during the second half of 2021, in order to develop a strategy whose core objective is to maintain the quality of teaching. The strategy will be subject to internal consultation in the ETH Domain before it is adopted by the ETH Board.

Strategic objective

RESEARCH

In 2021, the institutions of the ETH Domain also conducted innovative research, which was reflected in a large number of awards. New directions were set and structures were created, especially in the areas of quantum sciences as well as energy, the environment and sustainability. There is concern about the lack of full association in the EU Framework Programmes for Research and Innovation.

Leading international position in research

In the reporting period, the development of centres and the launch of new research activities in the dynamic field of quantum sciences and technologies was one of the focal points, which enabled the ETH Domain to further strengthen its international pioneering role in this field. For example, the Quantum Computing Hub, which was founded last year, started its research in Villigen. The centre, jointly operated by ETH Zurich and the PSI, aims to develop quantum computers. For the first time, two different technologies – superconducting components and ion traps for quantum computing – are combined under one roof, in order to be able to use synergies (see also p. 16). EPFL has created a new Center for Quantum Science and Engineering (QSE), which is aimed at developing quantum technologies for a range of scientific and technical applications using state-of-the-art nano-manufacturing facilities. The Center is characterised by its interdisciplinary focus and a close link between research and teaching. Empa, in turn, is involved in the development of carbon nanomaterials for quantum technologies (CarboQuant) and was able to raise third-party funds from the Werner Siemens Foundation in this context. In the field of basic quantum physics research, researchers at EPFL have succeeded for the first time in allowing photons to interact with pairs of atoms. This result has the potential to be included in the development of new quantum technologies.

Research in medicine and life sciences also played an important role in the ETH Domain. The institutions again dealt with COVID-19 in a variety of ways (see p. 56 as well as Objective 4 "Dialogue with society" and Objective 5 "Activities in the area of medicine and medical technology", p. 66 and 70). In addition, ETH Zurich is pursuing an approach which involves using artificial intelligence to examine the medical effectiveness of natural substances. A photoelectric implant has been developed at EPFL, which is applied to the spinal cord of mice and can potentially control the activity of nerve cells. Future medical applications arise in the treatment of pain, in the regulation of paraplegics' blood pressure and perhaps even in the treatment of paraplegia. At the PSI, the molecular structure of a special tubulin protein could also be deciphered using the large-scale research facilities and on this basis, a possible way to block cell division in certain parasites could be identified. This discovery is an excellent starting point for the development of medicinal products against diseases such as malaria or toxoplasmosis. Scientists from Empa and ETH Zurich have developed a method for combating multi-resistant bacteria. The pathogens in the body are detected and killed using new types of nanoparticles.

An important area of research was, once again, the environmental sciences, in the context of which, for

example, WSL launched the "Extremes" research initiative. See "Research priorities" below for more details on this subject area.

The excellence of the ETH Domain's researchers is reflected in exemplary fashion by the numerous awards they received in 2021. Prof. Nicola Aceto from ETH Zurich was awarded the Swiss Science Prize Latsis for his pioneering work in the field of cancer research. The European Inventor Award, Europe's most important innovation prize, was also awarded to two ETH Zurich scientists, Prof. Robert Grass and Prof. Wendelin Stark, for their research on DNA-based data storage. Anne Lacaton, Emeritus Professor at ETH Zurich, and her partner were jointly awarded the Pritzker Prize (the most important international prize for architecture). One of the prestigious BBVA Foundation Frontiers of Knowledge Awards was given to EPFL Professor, Michael Grätzel, for his pioneering contributions to the development of nanomaterials. Prof. Ali H. Sayed from EPFL was given the renowned IEEE Fourier Award for Signal Processing. In addition, Prof. Andrea Ablasser from EPFL was awarded the EMBO Gold Medal 2021. ETH Zurich and EPFL continue to hold top positions in the international rankings of the best universities in the world (see p. 99).

The ETH Domain is actively involved in the National Centres of Competence in Research (NCCRs). The two Federal Institutes of Technology are either leading house or co-leading house in 13 out of 22 of the current NCCRs, and the research institutes are also participating in them. For example, Empa is now involved in a project for electrochemical CO_2 reduction in NCCR Catalysis, which is led by ETH Zurich and EPFL. The institutions also participate in the National Research Programmes (NRP). Within the framework of the "Covid-19" NRP, the PSI is leading two projects that have already provided research results that can be used, for example, for the development of medicinal products against the virus.

Researchers from the ETH Domain were able to participate in two calls for proposals for ERC Starting Grants and Consolidator Grants in 2021, which were evaluated in a competitive EU-wide procedure. Researchers whose applications have been positively assessed are funded by the State Secretariat for Education, Research and Innovation (SERI) through national funds, as Switzerland is currently treated as a non-associated third country within the EU Framework Programme for Research and Innovation "Horizon Europe" (2021–2027). The applications of 18 researchers from the ETH Domain for ERC Starting Grants received positive evaluations, and the results for the Consolidator Grants are still pending. In place of ERC Advanced Grants, the Swiss National Science Foundation (SNSF), on behalf of SERI, conducted a national tender and launched SNSF Advanced Grants as part of the transitional measure "Temporary Backup Schemes". Transitional measures were also created for the European MSCA Postdoctoral Fellowships (see also Objective 6, p. 73).

Complementary competencies in the ETH Domain

The institutions of the ETH Domain work closely together to complement each other in an optimal way through their different core competencies and to exploit synergies. To that end, the ETH Board now funds a total of six cooperation projects and initiatives. In this context, the two Federal Institutes of Technology and the International Committee of the Red Cross (ICRC) have launched the Engineering Humanitarian Aid project, which aims to respond better to the challenges of humanitarian work by means of technological innovations. Furthermore, ETH Zurich and the PSI launched a Materials Discovery Initiative, which will set up a joint laboratory at the Hönggerberg site, but will also use the PSI's large-scale research facilities. The aim of the initiative is to create the necessary infrastructure for the innovative synthesis of materials with new types of electronic, photonic and magnetic properties. Together with Empa, the PSI has launched the SynFuels initiative, which is developing a process to produce kerosene and thus sustainable synthetic fuels using renewable energies. In the field of environmental research, the ETH Board is funding a research initiative to examine biodiversity at the interface of aquatic and terrestrial ecosystems: within the framework of Blue-Green Biodiversity, a joint venture of WSL and Eawag, different long-term research projects were launched in 2021.

Research activities in the energy sector

The ETH Domain is particularly committed to energy research. The institutions play a very important role in the newly launched SWEET (SWiss Energy research for the Energy Transition) funding programme of the Swiss Federal Office of Energy (SFOE). This promotes innovations that are intended to make a significant contribution to the successful implementation of the Energy

Applied research: Eawag is searching for cyanobacteria in the Greifensee. The results can be integrated into water protection and water management (see also p. 32).

Strategy 2050 and to the achievement of Swiss climate targets. A total of four consortia were selected as part of the first call for proposals, three of which are managed by institutions of the ETH Domain. The EDGE consortium, which is jointly run by EPFL and the University of Geneva, in which several other institutions including ETH Zurich are participating, aims to promote the expansion of decentralised renewable energies and to make the Swiss energy system technically and economically more stable by 2050. As a partner organisation of EDGE, WSL is investigating the role of biomass in a decentralised energy system. Recently, the research institute, together with EPFL, was able to show in a study that the installation of wind turbines in combination with solar modules in the Alps is an effective solution for achieving energy neutrality in Switzerland. The PSI-led consortium SURE is investigating how Switzerland's energy supply can be guaranteed in a way that is as sustainable and error-free as possible. The SFOE also funds the PATHFNDR consortium under the leadership of ETH Zurich and with the participation of EPFL, the PSI and Empa. The aim is to develop ways to create an efficient, flexible, robust, cost-effective and sustainable Swiss energy system. Empa and ETH Zurich are also partners in the fourth consortium DeCarbCH under the leadership of the University of Geneva. The institutions of the ETH Domain are also active in other projects and programmes in energy research. In a study, Eawag was able to show that energy recovery in the household, for example from shower water that is still warm, makes sense.

Enhancement of computer sciences and information technology

The enhancement of computer sciences and information technology is a central issue in the ETH Domain. The two Federal Institutes of Technology were able to fill almost all of the professorships financed from federal funds for the purpose of increasing expertise in the field of digitalisation and to create further professorships from their own resources. The PSI also took an important step in the promotion of computer sciences and information technology by establishing a new Scientific Computing, Theory and Data (SCD) research division. SCD fundamentally supports computer-aided science in all fields of research and the large-scale research facilities of the PSI, but it also strengthened them specifically by creating two joint professorships with EPFL in the priority areas of physics and materials research.

The institutions are also strengthening computer sciences and information technology in the field of teaching. The institutions offer various training and further education opportunities for teachers, in order to create innovative and well-founded forms of digital knowledge transfer for young people in Switzerland. The Training and Advisory Centre for Computer Science Teaching (ABZ) at ETH Zurich supports schools and teachers who want to develop or expand their computer science teaching skills. In 2021, the teaching material series "einfach INFORMATIK" (Simply Computer Science) for pupils up to year 9 was completed. Together with universities of education, the Centre also held project days in schools, where 73,000 children in kindergarten through fourth grade worked with the new character-based programming environments of the ABZ. At EPFL, the Center for Learning Sciences LEARN,

which focuses on digital education at primary and secondary level, trained more than 1,400 teachers from the Canton of Vaud. In this context, a new CAS for computer science teachers at secondary level I was also launched. EPFL established another new centre for the development of digital education services called "BeLearn" together with the authorities and several universities in the Canton of Bern. EPFL's Science Outreach Department (SPS) also organises workshops to raise awareness of computer science among young people in German-speaking Switzerland, French-speaking Switzerland and soon also in Ticino (in a total of 13 cantons).

Protection against cyber risks

As part of the "National strategy for the protection of Switzerland against cyber risks", ETH Zurich and EPFL founded the Swiss Support Center for Cybersecurity (SSCC) in the previous year. The company is now operating and runs joint projects and workshops on cyber-related topics together with public authorities, universities and the private sector. In the field of cyber security research, EPFL developed the novel "FAMHE" analysis system together with the Lausanne University Hospital (CHUV) and scientists from MIT and Harvard University. It enables healthcare providers to perform statistical analyses without having to exchange the underlying data sets. This opens up new avenues in the area of personalised medicine, for example. The PSI, ETH Zurich, EPFL and the Swiss National Supercomputing Centre (CSCS) concluded the SCI-ED project, which was able to achieve fast and secure transfers of large amounts of data in several application examples. The cooperation partners made use of ETH Zurich's SCION Internet infrastructure.

Research priorities

Within the framework of the ETH Domain's Personalized Health and Related Technologies (PHRT) strategic focus area (SFA), two calls for proposals for interdisciplinary projects were launched. In 2021, numerous research projects were launched, promoted or realised. For example, researchers from EPFL have developed a method for printing biological tissue together with the EPFL spin-off Readily3D, which is used in the newly launched EU project ENable LIGHT to create a functional model of the pancreas for testing diabetes drugs. At the Empa, a research project on "digital twins" of patients was at the centre of the research interest (see p. 31 ff.).

At the heart of the Data Science SFA is the Swiss Data Science Center (SDSC), jointly operated by ETH Zurich, EPFL and the PSI, which provides data science services for all researchers and departments of the ETH Domain and beyond and achieves synergy effects with other SFAs. For example, the SDSC was able to assist WSL in establishing a purely data-based approach that provides reliable forecast results where the avalanche danger level is concerned. The SDSC entered into a pioneering new cooperation agreement with the Federal Statistical Office (FSO), which aims to make data science and artificial intelligence usable for administrative work. Another milestone in 2021 was the opening of a third SDSC hub at the PSI. This will not only expand the Center's content portfolio by focusing on data generated in large-scale research facilities, but will also provide the SDSC with more broad-based institutional support.

The institutions of the ETH Domain are also involved in the Advanced Manufacturing strategic focus area. Empa is a leading player and took a decisive step in the area of 3D printing in medical technology within the framework of the Swiss m4m Center (see also Objective 4, p. 65). The PSI was also able to launch four new projects in this SFA.

Energy, the environment and sustainability are another research priority of the ETH Domain. Climate change in particular is the focus of attention, as demonstrated by the establishment of the Center for Climate Impact and Action (CLIMACT) by EPFL and the University of Lausanne. The institutions address the link between climate change and extreme events within the framework of WSL's newly launched interdisciplinary and transdisciplinary Extremes research initiative (2021–2024) and in the context of the only recently founded CERC Centre, which WSL operates in cooperation with the Canton of Graubünden and with the participation of ETH Zurich. The topic of biodiversity and its political dimensions were also the subject of research. Specifically related to the use of pesticides, for example, the Synergia TRAPEGO (Transformation in Pesticide Governance) project was launched under the direction of Eawag and the University of Bern. In the field of sustainability, Empa investigated within the scope of a feasibility study whether rubber from old tyres can be reused in asphalt on Swiss roads. ETH Zurich, in turn, founded the Center for Sustainable Future Mobility (CSFM), a Competence Centre which aims to lay the foundations for sustainable transport systems. For the field of energy research, see the Research Activities in the Energy Sector section.

In the reporting period, the ETH Board and the institutions of the ETH Domain decided to strengthen their support for the topic of open research data during the current ERI period. A steering committee made up of representatives from the institutions of the ETH Domain is currently working on the implementation of various measures, in coordination with the Swiss National Open Research Data Strategy, which are intended to support initiatives by researchers in the ETH Domain.

A core concern of the ETH Domain is also the preservation of scientific integrity, which together with good scientific practice is a basic prerequisite for excellent research. The institutions offer numerous training, further education and awareness-raising activities for their researchers. In the reporting period, the two Federal Institutes of Technology also worked on the revision of their legal bases for scientific integrity. In May 2021, the Swiss Academies of Sciences published a code of conduct for scientific integrity, which is intended to create common standards in Switzerland and is welcomed in the ETH Domain. The ETH Domain has set up a working group to examine how best to implement the recommendations of the code and whether uniform or at least harmonised regulations on scientific integrity can be drawn up in the ETH Domain.

Strategic objective

RESEARCH INFRASTRUCTURES

The institutions of the ETH Domain develop and operate large-scale research infrastructure of national and international importance. With the new ERI period 2021–2024, the research infrastructure projects included in the Swiss roadmap have entered their implementation phase. Work on the preparation of the Swiss roadmap for the period from 2025 to 2028 has also begun.

Operation, further development and provision of large research infrastructure

The institutions of the ETH Domain develop and operate important research infrastructure which they make available to partners from science and industry. Some important milestones were reached in 2021. The PSI continued to expand the SwissFEL X-ray free-electron laser. At the Maloja experimental station of the ATHOS beamline, initial testing time slots were granted and and a first call for projects for the investigation of ultrafast processes was carried out. In March 2021, the ATHOS beamline reached the new Furka experimental station for the first time, so that the first test experiments could already be carried out in the summer of 2021. Furka will specialise in the investigation of materials at very low temperatures. The first scientific experiments are planned from 2022 onwards. Users of the ARAMIS beamline from SwissFEL now have the opportunity to carry out dedicated SFX measurement campaigns (serial femtosecond crystallography) in the Alvra experimental station. This opens up fundamentally new possibilities for structural biology to determine molecular structures previously inaccessible to crystallography. In the reporting period, experiments at the other large-scale PSI facilities, in particular at the Swiss Light Source (SLS) and the Swiss Spallation Neutron Source (SINQ), led to important scientific findings. As an example, the structure of the shell of a brachiopod, the properties of which could be used as bone replacement in medicine, was decoded by electron cryotomography at the SLS. Despite the coronavirus pandemic, the PSI was able to maintain the operation of its large-scale facilities virtually without restrictions throughout 2021. The number of experiments carried out was of the same order of magnitude as before the pandemic, while the number of applications submitted for testing time slots reached a new record. This could be due in part to the international renown of the SwissFEL and the successful upgrade of the SINQ. The average annual availability of PSI accelerators for the four years between 2018 and 2021 was 95.8%. Around half of the testing time slots were booked by Swiss groups, and predominately those which belonged to the ETH Domain. The PSI's facilities are still heavily used by industry. The limited possibility for users to conduct experiments on site was offset by the possibility of remote access, a high degree of automation and excellent maintenance of the instruments on site. In the long term, however, this development will lead to capacity limits being reached, as highly complex experiments can only be developed and carried out if the users are on site.

In 2021, the User Lab provided IT resources at ETH Zurich's Swiss National Supercomputing Centre (CSCS) in the context of various project calls. In the reporting period, numerous projects were approved on the occasion of two national calls and the Partnership for Advanced Computing in Europe (PRACE) call. The ap-

plications for computer time slots still greatly exceed the available capacity.

In the reporting period, the Blue Brain (BBP) neuroinformatics project at EPFL refined its models of the different regions of brain tissue, paving the way to make them available. The BBP can now aim to model an entire rodent brain. In 2021, BBP used its brain simulation technology to portray the influence of blood sugar levels on the severity of COVID-19 diseases. This these model's novel approach uses artificial intelligence and machine learning to explore the largest collection of freely accessible scientific publications on SARS-CoV-2, extract information from it, and sift through collective knowledge to find a common root cause of severe progression of the disease. A new MOOC (Massive Open Online Course) was also launched to help users to make optimal use of the capabilities of BBP infrastructure to conduct in silico experiments. The instruments of the BBP were also used in the European research infrastructure EBRAINS (see p. 62).

Two new units were inaugurated in 2021 at NEST, the modular research and innovation building of Empa and Eawag for the construction sector. Construction of the HiLo unit with its doubly curved concrete roof and adaptive façade with solar cells was completed in June and inaugurated in a virtual ceremony. The Sprint unit, which was built in just ten months – mainly from recycled materials and components – opened in August. Sprint sets new standards for the circular economy in the construction sector. The new unit, STEP2, which is intended to stimulate further innovation in the circular economy, industrial and digital manufacturing, as well as for building envelopes and energy systems, is in the planning phase.

Swiss Roadmap for Research Infrastructures: Implementation of the strategic projects

The Swiss Roadmap for Research Infrastructures is the central planning instrument of the Federal Government. In 2021, significant progress was made in the implementation of the three research infrastructure projects of the ETH Domain included in the Roadmap 2019 for the period 2021–2024. ETH Zurich's CSCS reached an important milestone in the implementation of the HPCN-24 (High Performance Computing and Networking) strategy as part of the strategic partnership with the manufacturer of the Cray supercomputer (which belongs to Hewlett Packard Enterprise): the first components of the new Alps infrastructure were installed and put into operation. This will replace the Piz Daint supercomputer from 2023 onwards. The development of the architecture for this new infrastructure is going according to plan. The PSI has launched the implementation phase for the upgrade of the Swiss Light Source (SLS 2.0). Extensive preparatory work is required to ensure that the shutdown of the SLS, which is required for this purpose, is of as short a duration as possible. In the course of 2021, for instance, progress was made in the planning for the upgrade of the beamline, the project structure was expanded and a

The HiLo unit with its doubly curved concrete roof and the adaptive façade with solar cells on the NEST.
› Empa

second internal crane was installed in the SLS building. Good progress has also been made on the production of prototypes of various components of the accelerator. The Catalysis Hub (Cat+) is decentralised research infrastructure in two hubs, a shared one at ETH Zurich and Empa (Cat+ Ost) and the other at EPFL (Cat+ West). Cat+ aims to support the development of new types of catalytic processes in the field of renewable energies and chemicals. For this purpose, it uses state-of-the-art high-throughput technology in combination with computer-based data analysis based on artificial intelligence and machine learning. In 2021, capital goods were purchased and laboratory spaces were prepared for the installation of the equipment. The recruitment and employment of the first scientific employees has also begun, so that operations can commence in 2022.

In the reporting period, the State Secretariat for Education, Research and Innovation (SERI) started the preparatory work for the Roadmap 2023 for the period from 2025 to 2028. On the basis of the proposals prepared by the institutions of the ETH Domain, the ETH Board has selected the strategically important research infrastructure projects for the relevant period and submitted them to SERI. The scientific quality of the submitted projects will be evaluated by the Swiss National Science Foundation (SNSF) from the beginning of 2022.

Involvement in international research infrastructure

The institutions of the ETH Domain play an important role on the European and global level due to their contributions to large-scale international research infrastructure. Since 2016, EPFL has been coordinating the Swiss research community which is involved in the Square Kilometre Array (SKA), the largest radio telescope ever built. Since the beginning of 2021, SKA has been an international organisation (SKAO) in which Switzerland, represented by EPFL, has observer status. In June 2021, EPFL concluded a cooperation agreement with SKAO on a scientific and technical basis for the period from 2021 to 2023. The PSI is participating in the construction of five of the planned instruments of the European Spallation Source (ESS) in Lund, Sweden. The construction of the reflectometer (ESTIA), which will be fully realised by the PSI, reached a significant milestone in June 2021 with the arrival of one of the most important optical components at ESS.

ETH Zurich is coordinating Switzerland's contribution to the Integrated Carbon Observation System (ICOS), in which Empa and WSL are also involved. Amongst other things, this European infrastructure allows the observation of the concentration of greenhouse gases in the atmosphere. The data collected was included in the Global Climate Report of the Intergovernmental Panel on Climate Change (IPCC) and thus contributes to the information used for the political decision-making process in the fight against climate change. In addition to the two already certified measuring stations in Davos and on the Jungfraujoch, a new station is currently being built in Basel. EPFL's Swiss Plasma Center (SPC) is one of the most important centres for nuclear fusion research in Europe and plays a crucial role in the work of EUROfusion, the European consortium dedicated to fusion energy. It also makes a direct contribution to the International Thermonuclear Experimental Reactor (ITER) project. In 2021, EUROfusion entrusted EPFL with a project in the field of high-performance computing. This project is intended to provide scientific and technical support to European scientists working in the field of nuclear fusion and underlines once again SPC's outstanding skills.

The European Strategy Forum for Research Infrastructures (ESFRI) published an updated roadmap in 2021, using a thorough evaluation process to select the best scientific infrastructure in Europe. The institutions of the ETH Domain are involved in several of the eleven infrastructures listed on the roadmap. ETH Zurich and EPFL are leading the Swiss contributions to two of these infrastructures: SoBigData++ and EBRAINS. The latter is the digital research infrastructure that the Human Brain Project (HBP) will replace after the end of its last financial period in 2023. EPFL was the coordinator of the HBP, but in 2021 it transferred this responsibility to EBRAINS AISBL, a legal entity domiciled in Brussels. With immediate effect, it is the coordinator of the Swiss hub.

Strategic objective

KNOWLEDGE AND TECHNOLOGY TRANSFER

The current key figures on patents, cooperation agreements and spin-offs underline the contribution of the ETH Domain to enhancing Switzerland's innovative strength and competitiveness. In the reporting period, the institutions of the ETH Domain also maintained a direct dialogue with society in a variety of ways. Once again, the focus was on providing scientific support to policy-makers in the management of the coronavirus pandemic.

Research cooperation with the Swiss business community and the public sector

In the reporting period, the institutions of the ETH Domain registered 213 new patents and 181 licences as well as 330 invention disclosures and 39 software notifications (see p. 97). In addition, there were 548 collaboration agreements with the private sector and 272 with the public sector (see Fig. 14, p. 98). These key figures represent the whole process, from successful transfer of scientific findings to the development of marketable products. An important prerequisite for this is the constant dialogue of the institutions of the ETH Domain with Swiss SMEs and large companies. At this year's ETH Industry Day, for example, several hundred visitors were presented with ETH Zurich's wide range of inventions. The prizes of the CSEM Digital Journey 2021 were awarded at the "FORWARD" event organised by EPFL and Le Temps. In 2021, not just two, but three SMEs received a prize. Empa took part in the online Thurgau Technology Day for SMEs, where the research institute presented itself to an interested audience as a bridge to basic research. In February 2021, the PSI organised a virtual event for industrial partners in collaboration with the Swiss Industry Liaison Office, specifically in the context of preparations for numerous allocations as part of the realisation of the SLS 2.0 upgrade project (see Objective 3, p. 62). The share of about a quarter of all Swiss companies shows the high interest of domestic companies in becoming directly involved in the project. In an effort to optimise its support for SMEs, EPFL conducted a study on the SME customer journey to innovation. The aim of this study was to better understand the approach of and challenges faced by SMEs in their innovation processes. The results can be used to improve SMEs' access to knowledge and technology through adapted services. Important incentives for cooperating Swiss SMEs are often also provided by the Innosuisse funding agency. Innosuisse regularly finances cooperation projects between industry and the university through the Alliance innovation programme at EPFL. In the reporting period, the "Source d'innovation" competition, which is intended to motivate companies to carry out feasibility studies, was launched. At ETH Zurich, Innosuisse is involved, for example, in the "Funding Innovation Event" for researchers and industry representatives. Various institutions of the ETH Domain are also participating in the new Innosuisse Flagship initiative, which aims to stimulate innovation in areas relevant to a large part of the economy or society. Among the selected projects, for example, are flagships run by ETH Zurich, EPFL, the PSI and Empa, out of a total of five in the field of decarbonisation. In 2021, WSL participated in an Innosuisse project through SLF, which is dedicated to the development of a cost-effective avalanche detection system.

In addition to industry, the public sector is also an important partner in the field of knowledge and technology transfer (KTT). In 2021, the research project N2Oara was completed by Eawag, Empa and ETH Zurich in collaboration with the Federal Office for the Environment (FOEN) and several cantons. The aim of the project was to quantify greenhouse gas emissions from the purification of waste water. On behalf of various federal agencies and the Swiss Federal Nuclear Safety Inspectorate (ENSI), WSL coordinated the "Extreme flood events on the River Aare" study, in which ETH Zurich, EPFL, PSI and eight other partners were involved. This means that authorities and plant operators now have sound foundations to better protect critical infrastructure, such as nuclear power plants, from extreme flooding.

The KTT to strengthen Switzerland's competitiveness ultimately also always has a global aspect, which is reflected in the form of international alliances and projects. For example, EPFL cooperates closely with various universities within the framework of the EuroTech Alliance and in this context supported the TECHNION EuroTech Innovation Day, which was held in the reporting period. Big companies active on an international scale once again invested large amounts in implementing research into new technologies. For example, the major Tumor Profiler cooperation project from ETH Zurich and the University of Zurich, with various university hospitals and the Roche Group, was completed in 2021. It successfully dedicated itself to personalised cancer therapy. WSL participated in the European DIGIPLAN project for digitalisation and comparative analysis of spatial planning processes, from which 20 recommendations were developed for policymakers.

Favourable conditions for KTT and enterprise

In order to support students and researchers in their entrepreneurial beginnings, the institutions of the ETH Domain have a wide range of fellowship and advisory services. In addition to tried-and-tested offers such as the ETH Zurich Pioneer Fellowships, the EPFL Innogrants and the PSI Founder Fellowships, new instruments were also launched in 2021. For instance, EPFL added a programme component to its support for start-up projects aimed at preparing those involved for accelerated commercial implementation. At Empa, Entrepreneur Fellowships were introduced for researchers who want to become entrepreneurial on the basis of their work at Empa. An important offer is also the Successful Patent Search workshop for employees of Empa and Eawag, which focuses on the implementation of efficient and structured patent research.

Major efforts have been made to promote deep-tech start-ups and start-ups using digital technologies and artificial intelligence. This will drive forward applied solutions in forward-looking research fields that are becoming increasingly important for business and society. At EPFL, for example, a unique funding path has been established for the creation of start-ups based on groundbreaking technologies. In this context, the innovative platform "Enable-by-Design" was successfully implemented to accelerate start-up projects through the collaboration of companies and designers. At ETH Zurich, the ETH AI Center, which was founded in 2020, is dedicated to the path from research to start-ups as a career. The "Talent Kick Programme" promotes interdisciplinary teams and practical entrepreneurial experience during the course of studies and is now being rolled out throughout Switzerland after the successful pilot test in German-speaking Switzerland. ETH Zurich is also a founding member of the European Deep Tech Alliance Initiative. Since the summer of 2020, two joint events have already been held, which have served to network with industry partners and investors.

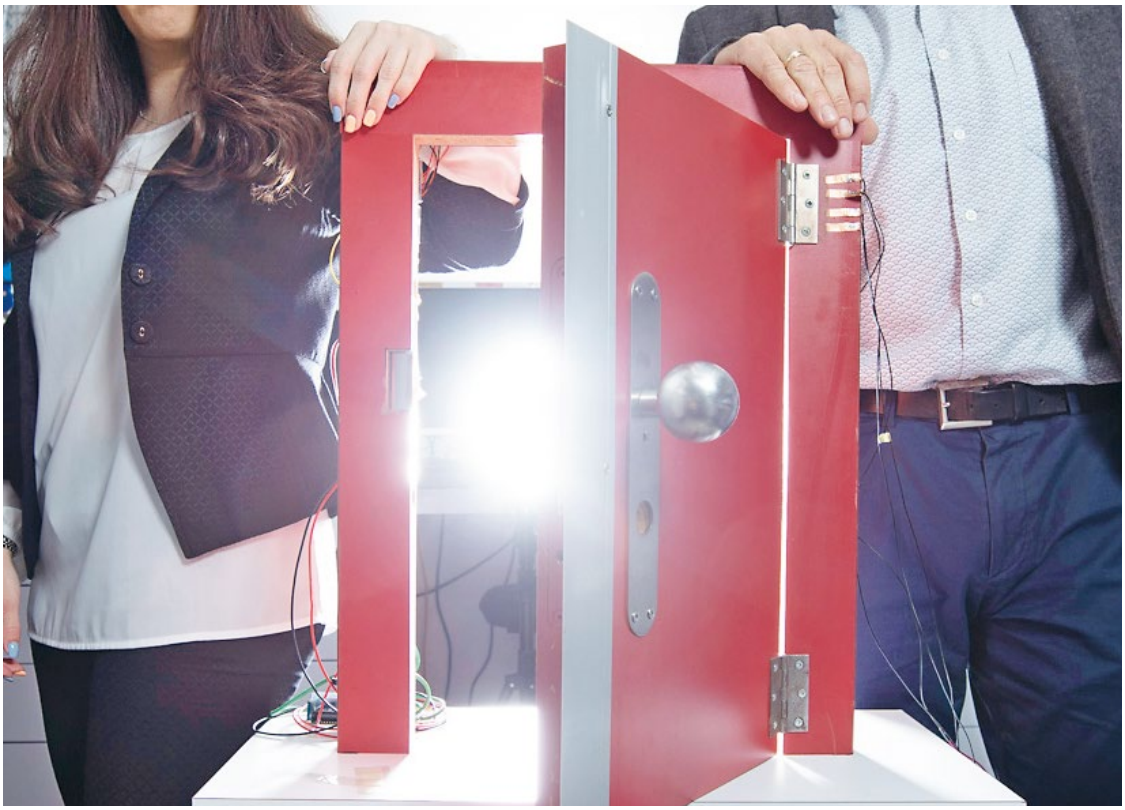
The various funding offers are often directly reflected in the formation of spin-offs. The corresponding figure for the ETH Domain in 2021 is 60 (see p. 97). A current example is XRnanotech, a spin-off derived from a PSI Founder Fellowship, which deals with novel nanostructured X-ray optics and was awarded the Deep Tech Pioneer title by the Hello Tomorrow Global Challenge. The spin-off received financial support from the ESA Business Incubator Centre Switzerland, amongst others. The Swiss incubator of the European Space Agency (ESA), which plays a pioneering role for all ESA incubators in Europe, extended the contract with ETH Zurich as the lead institution for another five years in the reporting period. The success of a spin-off can also be measured by an IPO. In 2021, for instance, three EPFL spin-offs were listed on the stock exchange: Sophia Genetics, Astrocast and Onward.

National network of technology transfer centres in Advanced Manufacturing

In the context of the Federal Government's "Action Plan for Digitalisation", the ETH Domain played a key role in the establishment of the association of technology transfer centres in the field of Advanced Manufacturing (AM-TTC). The two centres ANAXAM and Swiss m4m have been operating since mid-2020 and have already gained numerous new partners and customers. ANAXAM, which offers the industry applied material analysis at PSI's large-scale research facilities, dedicated itself in 2021 to, amongst other things, a customer project that serves the quality assurance and further development of the process of producing electric motors. The Swiss m4m Center, which was initiated and co-founded by Empa and has set up a pilot production line for the manufacture of implants by means of 3D printers, was awarded the ISO certification required for the quality assurance of medical devices in April 2021. Both centres will be supported by the Federal Government as research institutions of national importance in the four-year period from 2021 to 2024. In September 2021, the AM-TTC Alliance launched a second call on behalf of SERI, in which two to three further centres are to be set up as public-private partnerships with financial support from the Federal Government.

Strong involvement in Switzerland Innovation

With the aim of further improving the networking of the science and business sectors and providing innovation-friendly conditions for companies and researchers, the institutions of the ETH Domain are participating in the various locations of the Swiss Innovation Park. In the reporting period, various projects, including the world's only Immersive Wave Lab, were located at Hangar 3, leased and converted by ETH Zurich, on the Dübendorf airfield. In particular, projects in the fields of robotics, mobility and aerospace benefit from the establishment in Dübendorf, as they can use the many different testing possibilities on the ground and in the air. The EPFL Innovation Park Lausanne is still fully occupied, but thanks to the KNOVA programme launched in May 2021, it can still enter into new partnerships with companies. KNOVA enables companies to gain a one-year insight into the innovation potential of the academic world and is used to establish relationships. In 2021, the higher-level Park Network West EPFL in French-speaking Switzerland added to its range of services, including the creation of a customised soft landing programme. In September 2021, the Park Innovaare celebrated a milestone in the creation of the new innovation campus with a topping out ceremony including more than 300 guests from the fields of science, business and politics. The PSI supports the park in implementing its strategy of attracting companies that mainly operate on an international scale. With the decision of the Federal Council in April 2021, the new Innovation Park East will also integrate Eastern Switzerland into the Switzerland Innovation network in the future. The main site of the Innovation



Hard times for burglars and safe-crackers: Empa researchers have developed an invisible "keypad" made of printed, transparent electronics (see also p. 29).

Park East is located in the immediate vicinity of Empa St. Gallen, which also participates in the foundation of Switzerland Innovation Park OST AG and is represented on the Board of Directors.

Dialogue with society and tasks assigned by the Federal Government

The institutions of the ETH Domain research socially relevant issues and are committed to raising public awareness of research and technological developments. In 2021, they also participated in a large number of activities to maintain this dialogue. Together with the University of Zurich, ETH Zurich organised the Scientifica for the seventh time in September, attracting thousands of visitors. PSI researchers from the fields of radiochemistry and radiopharmacy also presented their latest scientific findings there. With the focus-Terra exhibition, ETH Zurich opened a new special exhibition in the information centre for the earth sciences in the reporting period that is dedicated to waves in all their manifestations. The institutions of the ETH Domain are also able to prepare findings in an interesting way for the public with guest contributions at external exhibitions, trade fairs or broadcast formats. For example, Empa and ETH Zurich were present at this year's OLMA fair in St. Gallen where they highlighted the issues of climate-neutral mobility and sustainable agriculture respectively, and the PSI was able to present its research contributions, in particular on synthetic fuels, in the SRF programme Einstein.

Not least as a result of the pandemic, the institutions also expanded their online offerings. Since mid-2021, it has been possible to go on a virtual tour of the research and innovation building NEST of Empa and Eawag. The launch of the tour, in which the individual building modules as well as the overarching research platforms, such as the Eawag Water Hub for decentralised waste water treatment, can be visited, is a further step towards closing the gap between the research laboratory and the market. The PSI also broke new ground and now gives people the opportunity to take online tours through its large-scale research facilities.

A special concern of the institutions of the ETH Domain is the close dialogue with schools and baccalaureate schools to promote the interest of young people in the subjects of science, technology, engineering, and mathematics (STEM). In this area, too, online offerings played an important role in the reporting period. Together with WSL, the "SRF school" created four new video contributions on the topic of "Switzerland's forests", in which researchers from WSL show their work locations and explain why forests are important and worthy of protection. The iLab student laboratory at the PSI developed two digital teaching modules for the Energy System Integration Platform (ESI platform) and the Swiss Light Source (SLS). At ETH Zurich, the new ETH Youth Academy started operating and enabled pupils from various baccalaureate schools in German-speaking Switzerland to take part in courses such as "The Chemistry of Climate Change" or "Algorithmic Thinking in Practice". Empa participated in the "Jules Vernes Children's Technology Campus", in the technical weeks of the baccalaureate schools and in the "Smartfeld" educational initiative of the St. Gallen University of Teacher Education.

The dialogue with society also includes the consultation of authorities and political decision-makers in the context of topical issues. As was already the case in 2020, numerous researchers from the ETH Domain dedicated themselves to finding solutions in connection with the coronavirus pandemic. Various official mandates were added to the involvement in the Swiss National COVID-19 Science Task Force. For example, on behalf of the Federal Office of Public Health, a research team from Eawag dedicated itself to "estimating the effective reproduction number of SARS-CoV-2 in waste water", Empa developed a test concept for the Canton of Graubünden or led various projects on infection risks in indoor areas (e.g. cable car cabins), and researchers at ETH Zurich regularly calculated the estimated R value (reproduction number) for Switzerland.

Once again, climate change was a topic at the interface between science and politics, where the institutions of the ETH Domain were able to use their expertise in many different ways. Within the framework of the Federal Government's National Centre for Climate Services, various researchers from WSL and ETH Zurich participated in the Hydro-CH2018 project, which investigated the effects of climate change on the water situation in Switzerland and concluded, amongst other things, that more localised heavy rain is to be expected in the future and that this is likely to lead to more flooding. At ETH Zurich, several hundred interested parties from industry, science, business and politics took part in the 2021 Climate Change Meeting at input presentations and round-table discussions on "Net-zero: how do we achieve climate neutrality together?" Please also refer to the role model status that the ETH Domain has in this subject area (see Objective 8, p. 79 ff. and p. 24). The Lab for Science in Diplomacy, which ETH Zurich founded together with the University of Geneva in the reporting period, focuses on the international level. The mission of this interdisciplinary research centre for science in diplomacy is to provide scientific findings and methods for the diplomatic resolution of international conflicts.

Finally, the platforms and portals that the research institutions are currently developing in their specialist fields also provide important impetus for the networking of research and practice. In cooperation with, amongst other players, the Federal Office for the Environment (FOEN) and the Swiss Hydrogeological Society (SGH), the Swiss Groundwater Platform CH-GNet is being set up at Eawag, for example, in order to network research groups in Switzerland on the topic of ground-

water and to encourage dialogue between stakeholders. The knowledge portal operated by and for forest professionals from all over Europe "waldwissen.net", whose website was fully revamped under the leadership of WSL, won the bronze medal at the Best of Swiss Web Award in 2021.

In conclusion, please refer to some of the current events concerning the tasks assigned by the Federal Government to the ETH Domain in accordance with the Notes to the strategic objectives. Eawag and EPFL are home to the Swiss Centre for Applied Ecotoxicology (Ecotox Centre), which received a new director in 2021. In the reporting period, the Centre published its concept for assessing sediment quality in Switzerland and focused on providing information on microplastics in the environment. As part of its task in connection with the National Forest Inventory, WSL has published a number of articles aimed directly at forestry stakeholders, providing them with updates on the state and developments of the Swiss forest. The Swiss Seismological Service at ETH Zurich is participating in the InSight Mars mission of the American Space Agency (NASA), which discovered two major marsquakes in 2021. In addition, ETH Zurich runs the Center for Security Studies, which in 2021, for example, organised a public security policy information event by the Minister of Defence. The PSI supports the implementation of the national "Sectoral Plan for Deep Geological Repositories" for radioactive waste and examined cores of the three potential siting regions in the reporting period.

Strategic objective

COOPERATION AND COORDINATION

In the reporting period, the institutions of the ETH Domain worked intensively with each other and with other Swiss educational and research institutions. These include various research institutions of national importance, with which the strategic alliances were renewed in 2021. There was also a focus on the many different activities in the medical field, which are based on close cooperation with Swiss hospitals.

Cooperation within and outside the ETH Domain

Cooperation between the institutions of the ETH Domain takes place at many different levels and is constantly being strengthened. For research, reference should be made to the strategic focus areas and thematic priorities. In addition, special attention will be paid to the promotion of cooperation projects in which complementary competencies of the institutions are used (see also Objective 2, in particular "Making optimal use of complementary competencies in the ETH Domain" and "Research priorities" p. 56 and 58). The large research infrastructures are also important drivers of cooperation (see Objective 3, p. 60 ff.). In terms of teaching, joint Master's degree programmes and doctoral programmes, the participation of the research institutes in teaching and the joint support of doctoral students promote close dialogue (see also Objective 1, p. 50 ff.). In 2021, the research institutions also launched an initiative with which they plan to strengthen their cooperation in selected fields of science, administration and training opportunities, both internally and externally, over the next few years, thereby making a more flexible contribution to meeting the most pressing challenges facing science, business and society.

Cooperation beyond the ETH Domain is equally important. Often two or three institutions of the ETH Domain cooperate with other players in the Swiss education and research landscape. For instance, several of the National Centres of Competence in Research (NCCRs) from the fifth series have now been launched, pooling the competencies in the ETH Domain and beyond: in the NCCR entitled Automation, headed by ETH Zurich, researchers from Empa, EPFL and ETH Zurich are, for example, working together with experts from the University of Applied Sciences and Arts Northwestern Switzerland (FHNW). The institutions are also participating in platforms and institutions together with other partners. The LéXPLORE research platform on Lake Geneva is operated by Eawag, EPFL, the universities of Geneva and Lausanne and the French research centre CARRTEL. Recently, thanks to the measurements of the platform, it was possible for the first time to see how the circulation of the lake changes depending on the season. Together with the universities of Bern, Lausanne and Zurich, EPFL, ETH Zurich and WSL have founded the "Swiss Polar Institute" (SPI), which is recognised and financially supported by the Federal Government as a "research institution of national importance" for the current ERI period. In 2021, SPI carried out the Arctic Century Expedition in which researchers from 17 countries reached almost 83° north to carry out interdisciplinary work and measurements.

In the field of knowledge and technology transfer (KTT), the pooling of competencies also plays an important

role. In addition to the established joint technology transfer office of Empa and Eawag, ETH Zurich and EPFL are also working together in this area and, in the reporting period, collaborated with the University of St. Gallen on conducting two sessions of "Innovator Speed Dating", where start-ups and talents met virtually. In the future, the inclusion of universities of applied sciences in this format is planned. The geographical proximity of the sites of the ETH Domain's institutions is often the trigger for cooperation. One example is the now completed construction of chemical laboratory infrastructure at EPFL's Valais site in the new buildings of the canton's university of applied sciences.

A large number of further cooperation agreements have been signed at the level of individual research projects. In 2021, for example, a research consortium consisting of the PSI, the "Biozentrum" of the University of Basel and the University of Geneva published important new findings for the development of therapies against AIDS, cancer and inflammatory diseases in the context of a study on the chemokine receptor CCR5. WSL published the findings of the overview study on "Alps in climate change: Many species adapt too slowly", which it wrote in cooperation with researchers from the universities of Basel, Zurich and Neuchâtel as well as various international institutions. The study not only included data which had already been published in the analysis of over 2,000 species and their handling of climate change, but also relied heavily on data from the population (citizen science).

Structure of the Swiss higher education sector

The ETH Domain is making an important contribution to the coordination of university policy and the division of tasks in particularly cost-intensive areas by setting up and operating its research infrastructures, which are available to the entire Swiss research community (see also Objective 3, p. 60 ff.). Numerous scientists from the ETH Domain have also contributed intensively to the development of the specialist roadmaps for research infrastructures, which were published by the Swiss Academy of Sciences (SCNAT) in the reporting period as one of the foundations for the "Swiss Roadmap for Research Infrastructures 2023".

The institutions of the ETH Domain are also intensively participating in the collaborative projects that the Federal Government is supporting in the context of project-related contributions. In the period from 2021 to 2024, for example, in the field of digital skills in teaching, two major projects with EPFL as the leading house will be funded, in which ETH Zurich and various other universities will also participate. The ETH Board makes the funds for specific forms of participation centrally available to the research institutes of the ETH Domain that are not eligible for contributions. In 2021, Empa was thus supported in its commitment to the Materials Cloud Open Science Platform for materials science. The Connecting Women's Careers in Academia and Industry project, which was promoted and highly sought after in the field of equal opportunities until

Flora and fauna in the Alps are particularly sensitive to global warming. Amphibians like the grass frog (*Rana temporaria*) have hardly changed their seasonal activity or migrated to higher altitudes, as the study conducted under the leadership of WSL shows.
› Anne Delestrade

the early summer of 2021, in which all institutions of the ETH Domain and the University of Zurich participate under the leadership of the PSI, was able to secure its continuation for the next two years by means of a successful application to the Federal Office for Gender Equality (FOGE).

Strategic alliances

Within the framework of strategic alliances, ETH Zurich and EPFL cooperate with various research institutions of national importance. At the beginning of the new ERI period in 2021, the service level agreements between SERI and the supported institutions were concluded and the strategic alliances between the two schools were then also renewed. ETH Zurich cooperates with inspire AG, the competence centre for technology transfer to the mechanical, electrical and metal industries, and with IRB, the Institute for Research in Biomedicine. EPFL is in close dialogue with the Swiss Center for Electronics and Microtechnology (CSEM) and the research institute Idiap in Valais, which specialises in information technology and artificial intelligence. In addition to numerous research cooperation agreements, the cooperation also relates to the teaching and support of doctoral students. In the summer of 2021, EPFL was able to further deepen its cooperation with CSEM by concluding a framework agreement for the acquisition of a common infrastructure in the field of photovoltaic research at the Neuchâtel site.

There is another strategic alliance in place between EPFL and the Swiss Tropical and Public Health Institute (Swiss TPH). Two large joint SNSF Sinergia projects have now reached the halfway point. Numerous field studies were carried out as part of the African Contributions to Global Health project, whose data is currently being evaluated and prepared for initial publications.

Activities in the areas of medicine and medical technology

Within the scope of medical research, the institutions of the ETH Domain cooperate very closely with Swiss hospitals. Together with the Baden Cantonal Hospital, for example, ETH Zurich launched a new technology platform for clinical studies in the reporting period. The digital Trial Intervention Platform (dTIP) works with a network of clinical partners to support researchers and spin-offs in the implementation of clinical trials. Founded by EPFL, the University of Lausanne and the Vaud University Hospital together with the Fondation Defitech in 2019, the Defitech Center for Interventional Neurotherapies – NeuroRestore can now point to ground-breaking technologies for the treatment of paralysis. In the related field of neuroscience, the Catalyst Fund at EPFL once again sponsored projects in which academic and clinical teams work together in an interdisciplinary manner to develop vital treatments. In 2021, Empa concluded a cooperation agreement with the Inselspital Bern in the field of research on the dynamic musculoskeletal system, which also includes the joint construction of infrastructure. Personalised avatars are also an important field of research at Empa. Together with the St. Gallen Cantonal Hospital, therapy cycles were tested on such digital twins in 2021 (see also p. 58). At the PSI, radiobiological experiments are currently underway to show whether the protection of healthy tissue can be further optimised in proton therapy. In the reporting period, a radionuclide manufactured at the PSI was also used for the first time for the treatment of metastatic cancer in patients. Now, in the context of a cooperation agreement with the Inselspital Bern, concrete application possibilities are being sounded out.

Of course, in 2021, medical research also intensively devoted itself to dealing with SARS-CoV-2. The long-term antibody study conducted by the University Hospital Zurich to investigate the actual infection rate of the population, for which researchers from ETH Zurich, EPFL and the PSI, as well as British universities, produced a large amount of SARS-CoV-2 proteins needed for this purpose, is an example of this. In cooperation with the University of Bern, lung tissue from COVID-19 patients was examined at the PSI to detect the accumulation of water and immune cells in the alveoli by means of 3D X-ray microscopy at SLS.

As a contribution to the training of young medical professionals, ETH Zurich continued its Bachelor's degree programme in human medicine with 100 students per year following the decision in 2020 to continue the pilot operation. In addition, a number of Life Sciences Engineering Bachelor's degree programme graduates from EPFL once again took advantage of the possibility of the "Passerelle" to the Medical Faculty of the University of Lausanne, and in the context of the "Passerelle Bio-Ingénierie – Médecine", several Master's graduates from EPFL transferred to the University of Geneva's Faculty of Medicine.

Strategy for the sites of the institutions of the ETH Domain

The national and international presence of the institutions of the ETH Domain extends beyond their original sites. In order to ensure a coherent strategic approach and to identify challenges at an early stage, the ETH Board is developing a corresponding strategy. The work is progressing according to plan and is scheduled to be completed in the course of 2022.

Strategic objective

INTERNATIONAL POSITIONING AND COOPERATION

In 2021, the ETH Domain was able to further expand and strengthen global cooperation agreements and the excellent position of its institutions on an international level. This was not least due to broad-based alliance networks, international cooperation initiatives and a global commitment to bilateral cooperation.

Attractiveness of the ETH Domain

The institutions of the ETH Domain have taken numerous steps to remain attractive to the best foreign students and researchers. For example, "ETH Meets You" contributes to the international visibility of the institutions. Within the scope of this series, ETH Zurich held numerous events in Switzerland and abroad in 2021, at which researchers from ETH Zurich and experts from the fields of science, business and society exchanged views on the topic of RETHINKING LIVING and could enter into dialogue with an international audience. For example, ETH Zurich organised a debate on the need to restore ecosystems in the context of the "Rendezvous Bundesplatz" event with the large-format light projection "Planet Hope Comeback" on the Federal Palace.

The award of scholarships for international students and the creation of an international teaching and learning environment by summer schools and other courses are also key elements for increasing the attractiveness of the ETH Domain. With the "Excellence Fellowships" of the EPFL, the best Master's students, and since 2021 also Bachelor's students, can be attracted from Switzerland and abroad. For example, WSL organised a summer school in Davos, where international Master's students, doctoral students and postdoctoral researchers studied methods for long-term forest monitoring in times of climate change and air pollution. Within the framework of the Eawag Partnership Program (EPP), Eawag offered six scholarships for short research residencies for students from developing countries in the related problem areas of water scarcity, pollution, exploitation of resources and loss of biodiversity.

International mobility programmes are also an important means of making the ETH Domain more attractive to excellent researchers. In particular via the COFUND programme of the European Marie Skłodowska-Curie Actions (MSCA), promising young researchers from all over the world are funded. For example, the PSI was once again able to recruit numerous postdoctoral researchers for the implementation of research projects at the PSI via the COFUND programme PSI FELLOW-III-3i (2020–2025), which is still being funded under the EU Framework Programme for Research and Innovation Horizon 2020 – the predecessor programme of Horizon Europe. The PSI also coordinates the newly founded "Real-time Adaptive Particle Therapy of Cancer" (RAPTOR) Innovative Training Network within the scope of the MSCA (Horizon 2020). As part of this process, doctoral students are selected who will be able to carry out their research work at one of the network's European partner institutions, including the PSI. In the context of Horizon Europe, Switzerland is currently considered a non-associated third country. Therefore, the Swiss National Science Foundation (SNSF) set up a replacement programme for MSCA Postdoctoral Fellowships on behalf of the State Secretariat for Education,

Research and Innovation (SERI). With the Young Scientist Fellowship, Empa initiated a new programme that opens up the possibility for exceptionally talented young researchers to complete a two-year research residency at the research institute and thus receive seed capital for an academic career. Eawag also awards one postdoc scholarship per year for two-year research residencies. ETH Zurich, on the other hand, awards scholarships annually to up to ten excellent young scientists with an unconventional research idea as part of the Branco Weiss Fellowship – Society in Science programme.

International cooperation

The institutions are involved in international networks and strategic alliances. These cross-border cooperation agreements, which were also maintained as intensively as possible in the reporting period despite the coronavirus pandemic, are of great importance in order to ensure the excellence of the ETH Domain in research and teaching. The two Federal Institutes of Technology are members of the International Sustainable Campus Network (ISCN), the Global University Leaders Forum (GULF) and the European Association of Universities of Science and Technology (CESAER), which is particularly relevant for protecting the interests of Switzerland's universities vis-à-vis the European Union. ETH Zurich is also a member of the IDEA League, which is a form of cooperation between leading universities of science and technology in Europe. Bilateral agreements were reached with the IDEA partner universities in 2021 for a joint doctoral programme in geothermal energy called EASYGO. EPFL, in turn, is a member of EuroTech Universities. The research institutes are also involved in specialist international networks and strategic alliances. For example, Empa entered into a new partnership with the BioProducts Institute of the University of British Columbia and in this context also joined the transnational initiative Boreal Alliance, which enables dialogue in the field of bio-based materials research. Empa researchers also contributed to the configuration of the carbon dioxide monitoring satellite of the European Space Agency ESA. As a member of the LandAware association, WSL organised an international online conference on early warning systems for landslide events. In line with its commitment to scientific diplomacy, the PSI, together with CERN, represented the Swiss scientific community at an intergovernmental conference in Bern on the SEEIIST (South East European International Institute for Sustainable Technologies) project, which aims to establish a cancer research and treatment centre in South East Europe.

International cooperation is characterised by numerous bottom-up initiatives as well as thematic cooperation agreements and partnerships between the institutions of the ETH Domain. ETH Zurich and EPFL have agreed with Sofia University and the Bulgarian Government to support the establishment of a new Institute of Computer Science as an autonomous part of Sofia University. In the field of biomedical research, the PSI was able to identify with researchers from India the molecular mechanism of a rare hereditary disease of the respiratory tract, primary ciliary dyskinesia (PCD). These new

The Future Cities Lab (FCL) Global of ETH Zurich in Singapore contributes to making cities and settlement systems transdisciplinary and sustainable with specific European and Asian perspectives.

Participant Noviantari interacting with the ur-scape planning support tool at the "Java Archipelago City" design research charrette organised by FCL at SEC. The techniques and software developed are used to support planning for pandemic resilience in Indonesian cities.

› Carli Teteris/ Silk and Salt Images

findings, which were gained within the scope of the SNSF's Indo-Swiss Joint Research Programme, are intended to pave the way for innovative precision medicine therapies. Empa researchers participated in two international studies on the monitoring of CFC emissions. Within this framework, a sharp increase in the release of a banned ozone-depleting substance in East Asia was detected and located. It was later demonstrated that – thanks to rapid international action on the basis of the Montreal Protocol – emissions fell to previous levels.

The international locations of the two Federal Institutes of Technology play a major role in the worldwide reputation of the ETH Domain. At the Singapore-ETH Centre (SEC), which examines various aspects of urbanisation, the Future Cities Laboratory (FCL) programme will be given a new, more holistic approach for the period from 2021 to 2025. Under the new title "FCL Global", it will no longer only be cities which are taken into account, but also the networks between these centres and their surrounding regions. The SEC's researchers are therefore increasingly focusing their attention on roads, rivers, ports and airports in terms of land use and ecology. The EPFL Middle East campus in Ras Al Khaimah (United Arab Emirates) continued its activities in 2021. Talks on extending the partnership between EPFL and the government of Ras Al Khaimah have been delayed due to the pandemic and are currently continuing. In September 2021, the Minster of Higher Education of the United Arab Emirates visited EPFL, reaffirming his desire to establish a new model of cooperation. Initial negotiations have taken place.

Active role in the framework of the bilateral cooperation

ETH Zurich was once again commissioned by SERI as the leading house to coordinate Switzerland's bilateral research cooperation with China, South Korea, Japan and the ASEAN region (Association of Southeast Asian Nations) for the period from 2021 to 2024. Within the scope of this function, ETH Zurich enables cooperation between researchers at Swiss universities and Asian partners. For example, in its capacity as the leading house, ETH Zurich is coordinating a new programme of the Swiss-Thai Chamber of Commerce, which enables students from Switzerland to complete internships in Swiss companies in Thailand, in order to gain work experience in an Asian environment. The institutions of the ETH Domain are also active in South Asia. For example, the PSI's research into particulate emissions within the framework of an Ambizione grant will be extended to a particularly affected region in India and thus to so-called megacities. These studies of the PSI are also carried out in the framework of programmes supported by the Swiss Agency for Development and Cooperation (SDC). Also in South Asia, Eawag is working together with the University of Lausanne to promote a "south-south knowledge transfer" in relation to sustainable waste management systems. The aim of a special programme is to transfer waste disposal technologies and governance practices from Kerala (India) to various socio-cultural and political contexts in Nepal and Sri Lanka and to adapt them locally.

The African continent is also a priority region for bilateral cooperation. In 2019, EPFL created the Excellence in Africa (EXAF) Centre. In the meantime, the funding of six joint research projects between professors at EPFL and African universities has been secured. In addition, an initial call for proposals for doctoral projects was launched, which was met with a great response. Several scientific institutions on the African continent were also selected to become competence centres in the area of digital education. ETH Zurich's ETH for Development (ETH4D) initiative, which was also launched in 2019, was able to further expand its activities. For example, ETH4D enables Master's students and doctoral students to study at ETH Zurich through scholarships funded by ETH Zurich, SDC and the Sawiris Foundation for Social Development. The joint Master's degree programme for mechatronics engineers, which was founded in 2020 at Ashesi University in Ghana as part of the initiative, has now been accredited and preparations for the start of the first study cycle in 2022 have been completed. In a pilot project in Kenya, Empa researchers tested a computer model they developed to plan customised power grids for developing countries. Eawag offers further education courses on hygiene measures, as well as drinking and waste water systems in developing countries and humanitarian situations.

Strategic objective

SOURCES OF FINANCING AND ALLOCATION OF FUNDS

The stable total federal contribution of the Federal Government, together with the higher third-party funding, contributes to maintaining the independence of teaching and research. In 2021, the active management of the available reserves also made it possible to finance research projects in the strategic focus areas and strengthen the cooperation potential within the ETH Domain.

Allocation of funds based on relevant criteria
The ETH Board allocates federal funds (total federal contribution) to the institutions in accordance with Art. 33a of the ETH Act. The allocation of funding within the ETH Domain is governed by Art. 12 para. 2 of the Ordinance for the ETH Domain. The Federal Council's strategic objectives for the ETH Domain, which are tailored to the corresponding expenditure ceiling, form the basis for the ETH Board's target agreements with the institutions.

When making these annual allocations of funding to the institutions, the ETH Board draws upon the budget requests of the institutions, the attainment of objectives and the assessment of their academic performance. The institutions' financial burdens on the basis of their teaching, research and knowledge and technology transfer (KTT) activities, as well as the tasks assigned by the Federal Government, have thus been given due consideration. The funding effectively available to the ETH Board (budgetary credits) are then decided by the Parliament in December. Any changes in the funding available are taken into account when allocating funds in March of the following year.

The budget growth requested by the institutions of the ETH Domain for 2021 exceeded the federal funding available in March 2020. For the allocation of funds in 2021, the ETH Board therefore decided to cover the expenditure surplus of CHF 29m from the reserves of the ETH Board. The proposals submitted at the invitation of the ETH Board and selected by it for cooperation projects in the four strategic focus areas (SFA) were also financed from the reserves of the ETH Board with CHF 22m.

The Federal Assembly has approved a total of CHF 2,600m for the 2021 budget of the ETH Domain (FedD Ia of 16 December 2020) (see Fig. 1, p. 77).

The ETH Board allocated the funds for the base budget (base budget, total of CHF 2,442m) as follows:

- ETH Zurich CHF 1,255m
- EPFL CHF 670m
- PSI CHF 289m
- WSL CHF 61m
- Empa CHF 106m
- Eawag CHF 62m

Funding for the strategic projects of the ETH Domain:

- Research infrastructures/large-scale research projects: CHF 82m
- Strategic focus areas (SFAs): CHF 36m
- Cooperation projects: CHF 22m
- Incentive and seed capital funding, cooperation projects and other central and various expenses, as well as special funds: CHF 56m

Funding for the ETH Board:

- Own consumption by the administration of the ETH Board and Internal Appeals Commission: CHF 15m

Development of third-party funds
In the reporting period, the total federal contribution in 2021 amounted to CHF 2,604m, and revenue from third-party funding amounted to CHF 1,148m. Their share of the total sum of CHF 3,751m was 31% (rounded) and is thus slightly above the level of previous years. The total federal contribution accounted for 69% of total revenue.

The diversification of funding sources and responsible, economical management of the funding are important for the ETH Domain. Guaranteed long-term funding increases planning security and helps to ensure sustainable development. A long-term comparison shows that the share of third-party funding has increased (see Fig. 2, p. 77). This development corresponds to the strategic specifications set by the Federal Council, which expects a share of third-party funding of more than 31% by the end of the current ERI period.

The total federal contribution and its stable development form a reliable basis for maintaining the strategic freedom of action and the independence of teaching and research. Third-party funding and reserves contribute to financial flexibility. These are important conditions for strengthening Switzerland as a centre of research and for being able to compete internationally with technology-intensive research, which will keep us near the top of the rankings. Overall, the ETH Domain and its institutions are financially healthy and have a solid equity base.

The development of third-party funding in 2021 shows a positive overall picture. Compared with the previous year, revenue from third-party funds increased by CHF 24m (previous year: CHF 1,123m). The reasons are in particular due to the project revenue from the EU funding programmes (EU FP), recovered service revenues and the positive financial result.

In 2021, about one-half of third-party funding comes from competitive research funding projects at national and European level. Significant revenue comes from national research funding (the Swiss National Science Foundation SNSF and Innosuisse: CHF 309m, previous year: CHF 313m) and EU FP (Horizon 2020, ERC grants: CHF 160m, previous year: CHF 146m). Other significant sources of funding are from cooperation with the business sector (CHF 136m, previous year: CHF 136m), special federal funding of applied research (CHF 87m, previous year: CHF 80m) and the cooperation projects with the cantons, communes and various international organisations (CHF 95m, previous year: CHF 98m). The changes compared to the previous year depend, amongst other things, on the donors' announced research priorities.

Donations and bequests are also part of the revenue from third-party funding (CHF 122m, previous year: CHF 142m), as well as tuition fees and revenue from continuing education courses (CHF 56m, previous year: CHF 50m) and the various service revenues (other revenue: CHF 127m, previous year: CHF 114m) and the income from financing activities and investments (CHF54m, previous year: CHF 43m)

The indirect costs from third-party funded projects are also offset in such a way that the base budget is not jeopardised by these costs.

When making an overall assessment of the development of third-party funding, it is also necessary to take balance sheet transactions into account, in particular the development of dedicated third-party funds from contracts recognised in accordance with IPSAS 23. They indicate the inventories of project commitments for which services are still to be provided in the following years. The dedicated third-party funds remained stable in the reporting period (CHF 1,605m, previous year: CHF 1,608m). This consistently high volume will continue in future to have a positive effect on the research contributions as revenue and indicates that the required expansion of the funding base remains achievable in the short to medium term.

A further significant criterion for assessing whether the objective of third-party funding has been achieved is the commitments of funding (SNSF, Innosuisse and EU FP). It decreased by 17% compared to the previous year (2021: CHF 388m, 2020: CHF 468m, 2019: CHF 443m). The huge decrease in commitments of the EU FP of CHF 69m clearly shows the difficult position with regard to acquiring grants from the EU (Horizon Europe) and may slow future revenue development and achievement.

Maintaining teaching and research freedom
The two Federal Institutes of Technology and the four research institutes ensure that the research results of third party-funded projects can be published. They thus guarantee the unrestricted freedom of teaching and research. The publication freedom of and with supported people and projects is also guaranteed at all times.

Research freedom and the right to use research results are enshrined in the strategy for knowledge and technology transfer and in internal directives and are regulated and respected in the research contracts with the donors. In addition, the handling of donations is regulated explicitly by the code of conduct.

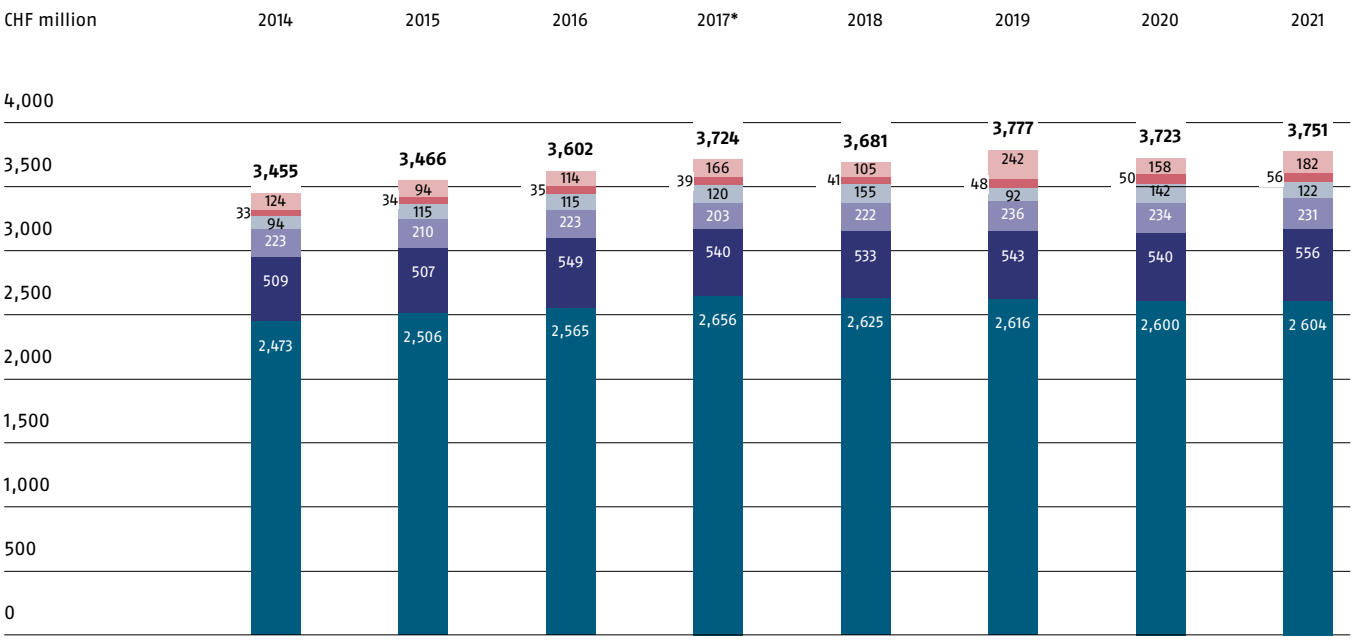
[1] This is referring to the total federal contribution of the Federal Government as accounted for in the consolidated financial statements of the ETH Domain (financing contribution of CHF 2,373m and the federal contribution to accommodation of CHF 230m). On the other hand, the two approved loans, which are credited to the expenditure ceiling, amount to CHF 2,600m (financing contribution or operating credit).

Fig. 1: Allocation of funding to the institutions of the ETH Domain
(after taking into account the reallocation in credit/funds within 2021)

CHF millions	2017	2018	2019	2020	2021	Δ 2020/2021 abs.	Δ 2020/2021 %
ETH Domain [1, 2, 9, 10]	**2,530.8**	**2,530.9**	**2,581.2**	**2,596.1**	**2,600.1**	**3.9**	**0.2**
ETH Zurich [3]	1,297.4	1,300.5	1,298.1	1,314.9	1,316.3	1.4	0.1
EPFL [4]	666.2	664.9	664.8	698.4	712.1	13.7	2.0
PSI [5, 6]	294.3	307.3	309.8	315.1	336.5	21.3	6.8
WSL	58.7	58.3	57.7	59.4	63.2	3.9	6.5
Empa [7]	114.7	105.2	115.7	114.8	126.9	12.1	10.5
Eawag	61.5	61.5	60.5	62.2	62.2	−0.1	−0.1
ETH Board [8]	38.2	33.2	74.7	31.3	−17.2	−48.5	n/a

Additional information on the budget/financial statements 2021:
1 Total allocation of funds in 2021
2 Annual tranches in accordance with the approved expenditure ceiling for 2021–2024 (credits taking into account the expenditure ceiling of the ETH Domain): annual tranche for 2021: CHF 2,588m/federal decree (FedD) on the budget according to FedD Ia for 2021: CHF 2,600m
3 Including upgrade of the Sustained Scientific User Lab for Simulation Based Science at the CSCS (HPCN-24): CHF 23m, start-up funding President: CHF 3m, development of the Catalysis Hub Cat+: CHF 5m, streamlining of the real estate portfolio: CHF 10m
4 Including the neuro information technology project, the Blue Brain Project: CHF 22m, development of the Catalysis Hub Cat+: CHF 7m, streamlining of the real estate portfolio: CHF 1m
5 Including upgrade of the Swiss Light Source (SLS 2.0): CHF 25m, Quantum Matter and Material Center (QMMC): CHF 3m
6 Including special funds (CHF 5m)
7 Including Next Evolution in Sustainable Building Technologies NEST and Empa Site Masterplan (Total: CHF 11m)
8 Including strategic projects, financing the dismantling of accelerator systems at the PSI (CHF 11m);
Reporting period 2021: negative return because CHF 51m of funds allocated in 2021 were financed from the reserves of the ETH Board.
9 Including strategic focus areas (Personalized Health and Related Technologies, Advanced Manufacturing, Data Science): CHF 36m
10 Including cooperation projects (total CHF 22m)

Fig. 2: Development of the sources of funding



2014–2021
Total federal contribution

Third-party funding:
Research contributions of the Federal Government and the EU
Research contributions of the private sector, other cooperation projects
Donations and bequests
Tuition fees, continuing education
Other revenue

* including sub-consolidation ETH Zurich and EPFL from 2017

Increase in efficiency and use of synergy effects

Joint initiatives and use of research infrastructures result in significant synergy effects. These include projects relating to the strategic focus areas (SFAs) or the cooperation of the four research institutes on the ENRICH project, which started in 2021 and involves shared activities relating to NetZero, sensors and the creation of a joint further education programme. The Swiss Data Science Center (SDSC) is a joint venture between EPFL, ETH Zurich and the PSI, enabling the pooling of forces in the key field of data science. Other current examples include the ETHZ-PSI Quantum Computing Hub, which opened in 2021 for the purpose of developing quantum computers and the realisation of a larger ETH Zurich infrastructure (wind-water tunnel) on the Empa-Eawag campus in Dübendorf. In addition, six cooperation projects were launched within the ETH Domain, e.g. SynFuels (Synthetic Fuels from Renewable Resources, Empa and PSI), which are supported with funds from the reserves of the ETH Board. This includes the Blue-Green Biodiversity research initiative, which was jointly implemented by WSL and Eawag, in which various joint projects are implemented across disciplinary boundaries.

In addition, synergies from various administrative and logistical commitments are also used. The research institutes Empa, Eawag and WSL operate the joint financial platform SAP 3RI and share the building organisation which is affiliated to Empa. The Empa-Eawag Technology Transfer Office also provides a jointly financed service, as well as supporting WSL in various transfer projects and third-party funding contracts. Another example is Lib4RI, the shared library of all four research institutes, which is housed at Eawag. The reporting platform on SAP FC is used in a cross-departmental manner. If new accounting standards are introduced, a joint and coordinated approach is taken where content is concerned. All institutions contribute human resources to the responsible centre of excellence IPSAS. In order to ensure an efficient operation, ETH Zurich is also pooling liquidity for the entire ETH Domain. Coordinated procurement within the ETH Domain (KoBe ETH+) and the procurement platform used together with the University of Zurich achieves significant savings.

ETH Zurich and EPFL achieve a similar synergy effect with different platforms that researchers use together within the institution. By pooling the equipment, the investments are optimised on the one hand and higher utilisation rates are achieved on the other hand. In addition, specifically trained internal teams reduce operating and maintenance costs. In all institutions, various digitalisation projects have been implemented in the research support processes or are being further advanced. This not only makes the organisation more efficient, but also more resilient to events such as the pandemic.

Reserves

In the context of the strategic objectives set by the Federal Council for the ETH Domain for the period from 2021 to 2024, the Federal Council expects the ETH Domain to reduce other equity (the sum of the reserves with internal dedication, the reserves without dedication and the accumulated surplus/deficit by 2024) by at least 10%. For the reason of transparency, the reserve categories have been reclassified. The donations and gratuities and the reserves from associated entities are not included in the strategic objectives, as there is no room for manoeuvre where their use is concerned. They must be used in accordance with the donors' external specifications.

The reserve target size (other equity) amounted to CHF 1,402m as of the end of 2019. In 2020, the ETH Domain reduced the figure by CHF 42m, and it increased in the reporting period by CHF 37m. At the end of 2021 other equity amounted to CHF 1,397m. The reduction of reserves with internal dedication and reserves without dedication of CHF 80m was offset by an increase in the accumulated surplus of CHF 117m.

The reserves in the ETH Domain have been actively managed for years. As part of its reserve policy, the ETH Board issued guidelines on this topic for the ETH Domain in 2019. The institutions regulate the operational reserve management in internal directives and regulations. The details on the use of funds from the reserves are published in each case in the Financial Report of the ETH Domain.

The targeted appropriation of reserves for setting strategic focal points in teaching and research and realising large-scale research infrastructure is integrated into the institutions' budgeting and planning processes. This ensures that the reserves and all funds are appropriated in the ETH Domain in a sustainable manner in accordance with the strategy.

PSI: Dismantling and disposal of the accelerator plants

Radioactive waste arises from the use of nuclear energy and ionising radiation applications in medicine, industry and research (MIR waste). The Nuclear Energy Act and the Radiation Protection Act set out the requirements for disposal. The financing of the provision for the decommissioning of the PSI accelerator plants (CHF 540m) will be provided by means of annual savings which will be added to the financing contribution. By the end of 2021, the savings amounted to a total of CHF 46m (savings amount in 2021: CHF 11m). The PSI has so far used around CHF 7m (2021: CHF 3m) of the accrued savings for measures in connection with the dismantling.

Strategic objective

REAL ESTATE MANAGEMENT AND SUSTAINABILITY

Despite the coronavirus pandemic and its effects, real estate management can look back on a good year. The projects and construction projects could generally be carried out as planned. Delivery bottlenecks and delays only occurred in the second half of the year as a result of the global pandemic.

Strategy and long-term portfolio development
Based on the "spatial and financial master plans" (SFMP) 2021–2032 developed in 2020 for the six institutions, consolidation was achieved for the first time at ETH Domain level. The result is the verifiable proof that, as in the past ten years, the requirements of the Federal Government as owner of the real estate have been implemented and fulfilled. It also provides an outlook on the major structural and spatial developments and measures, and the financial requirements for the next four to twelve years. It was shown that the ETH Domain expects a total sustained increase in students and professors by 2032 compared to 2020. To meet the spatial requirements, the ETH Domain will need to expand its infrastructure (estimated +14% compared to 2019), which will justify to some extent the high level of investment that has been made to date.

The flexibilisation of office workplaces is becoming more tangible. Both the experience gained from the pandemic and the decision of the Federal Council to introduce desk-sharing for standard office workstations were incorporated into the development of a change concept for the ETH Domain. This was brought to the attention of the Federal Council at the end of 2021. Even before its implementation, ETH Zurich transferred two sections of the Executive Board with around 550 workplaces to the leased Octavo building in Oerlikon. Its open-space layout and partially applied desk-sharing were used as a pilot project for more potential outsourcing and concentrations of workplaces. The new **Federal Act on Public Procurement (PPA) / Ordinance on Public Procurement (PPO)** came into force on 1 January 2021. The aspects of quality, sustainability and innovation are weighted significantly higher than the price when it comes to awarding contracts.

At **ETH Zurich**, space on the Zentrum campus remains a tense issue. The cantonal building department's approval of the special building regulations for ETH Hönggerberg has resulted in considerable expansion reserves. Work also continued on the structure plan review in the perimeter of Lindau/Eschikon as a way of reducing the burden on the Zentrum campus. The planning progress for the Zurich Zentrum (HGZZ) is currently somewhat restrained, especially as ETH Zurich assesses its gain in development potential here as more modest than had been hoped for. Properties are currently being leased for ETH Zurich to provide short-term peak demand coverage. This leased space provides a flexibility reserve. Pending renovations require replacement spaces in rental properties, as there are no areas earmarked for swapping in the real estate portfolio.

EPFL analysed its real estate portfolio, paying special attention to the development of teaching and the possible effects of new teaching forms. MOOCs combine traditional forms of knowledge transfer with forums where teachers and students interact and collaborate in virtual learning groups. Such consider-

ations and experiences are relevant in the context of the coronavirus pandemic. To support this and supplement the existing EPFL-UNIL Hautes Ecoles master plan, the preparation of a master plan for the reconstruction and densification of the EPFL site was started. It should be available by June 2022.

At the **PSI**, future construction sites will be created when it takes possession of the Park Innovaare, due to the ongoing dismantling of the decommissioned nuclear installations and the demolition of buildings. This will provide the conditions for further densification of the site and the realisation of areas earmarked for swapping and thematic clusters as part of the PSI Campus 2030 plan. The strategic planning of the research topics relevant to **Empa** has shown that modern laboratories and cleanrooms will be required more in the future. In addition, the interaction and interdisciplinarity between the research teams is to be promoted by a suitable type of building. With the successful completion of the new FLUX laboratory building on the Dübendorf campus and the planned Limnion project in Kastanienbaum, **Eawag** is entering a consolidation phase. With the new research centre for climate research (CERC), **WSL** will certainly expand on its Davos site, while the replacement of the building section D will compensate for the shortage of space and provide the facilities required for the CERC.

In 2021, no substantial portfolio changes were made in the ETH Domain. Only one plot in Stallikon was transferred to the BBL portfolio. The lease rate of the ETH Domain remains low at 15.1% of the main usable spaces.

Real estate management in figures

The purchase value of the ETH Domain's real estate portfolio at the end of 2021 amounted to CHF 8.26bn. In terms of value, this represents about one third of the Federal Government's entire real estate portfolio. The book value is around CHF 4.13bn. The ETH Domain uses around 400 buildings on 124 plots of land. The main usable area reported at the end of 2021, which covers 1,007,930 m^2, is up 0.5% compared to 2020.

The mix of space (see Fig. 27, p. 104) with state-owned buildings for own use and use by others, and buildings rented by third parties (in m^2 main usable area since 2012) shows how some of the growth in recent years could only be covered using additional leased space. The growth in leased space after 2013 is attributable to the changes in the statistical allocation of space. Without this effect, there would be a steady decrease in the leased space.

Ongoing and completed projects of 2021

After the number of professorships at both universities and the need for state-of-the-art infrastructure increased further in 2021, demand for new buildings, extensions and repairs remains high, as in recent years. In 2021, numerous important new projects were launched to maintain value and functionality. Refurbishments are being carried out to improve use, operating costs, energy status, disabled access and earthquake safety etc.

At **ETH Zurich**, the major ongoing construction projects (investment volume > CHF 10m/project) were pursued: the new GLC research building with laboratory and office spaces for health sciences, the refurbishment and extension of the ML/FHK Machine Laboratory and the renovation of the covered car park on the Zentrum campus, the construction of the new HPQ physics building on the Hönggerberg campus and the new build for biosystems BSS in Basel. Major planning changes in the reporting period were the abandonment of the extension project and thus the decision for a conventional renovation of the cafeteria and multi-purpose building including the Polyterrasse MM. For the new GLC building project, a general construction company experienced considerable delays, construction defects and foreseeable additional costs, which will lead to an overrun of the approved credit. The ETH Board will request an additional credit for this. The financing of the additional costs will be covered by the ETH Domian's regular budget and is therefore budget-neutral for the Federal Confederation.

At **EPFL**, the master plan was developed further with regard to needed renovations, the general upgrading of the buildings of the first stage dating from the 1970s/80s and the possible densification of the site; it is set to be completed by June 2022. As part of the ongoing pandemic, further thought was also given to future developments relating to workplaces and teaching methods. The discussions with the city of Lausanne, other neighbouring communes and the Canton of Vaud to reassess both portfolios, which had already begun earlier as part of the EPFL-UNIL Hautes Ecoles master plan, were continued in 2021. The extension of the EPFL Energy Center (CEN) with integrated data centre (additional storey) and the lake water pumping station will be completed in 2022. It will be possible to open the DLL EL Engineering building at the beginning of 2022. Planning started on the reconstruction of all sanitary facilities in the CM building, including gender-neutral toilets and concepts for the reuse/recovery of waste water.

At the **PSI** , work continued on the two large-scale research facilities, SLS 2.0 and SwissFEL, and the investment project Park Innovaare (currently a construction shell). More than 450 employees from different departments of the PSI will move into the leased premises. An office concept has also been developed for the PSI, which will initially be implemented at the Park Innovaare, in new buildings (such as OBBA) and for larger conversions of existing buildings (such as WHGA). The results of the discussions within the PSI Campus 2030 working group will be incorporated into the preparation of the master plan for the PSI site. The

Eawag's newly constructed FLUX laboratory with biology, chemistry and training laboratories on the Dübendorf campus.
› Alessandro Della Bella

planners were selected for the construction of the new QMMC laboratory. This project and the construction project for the Kita Kiwi new build were in the preliminary project phase in 2021. Planning permission for the new OBBA building was issued at the end of 2020. The steel structure was completed for the new ORAB building, the extension of the Swiss Federal Interim Storage Facility. In spring 2021, **WSL** started construction of the replacement building House D (general constructor project) in Davos (see also p. 83), and for Birmensdorf the call for tenders for a project competition for a replacement new build of the workshop building was launched. Planning permission was issued for the construction project Master Plan Research Campus **Empa-Eawag**, stage 1 in February 2021 and construction work was able to commence. The heat pump commissioned for the new medium-temperature district heating network for the supply of the site in 2020 was supplemented in 2021 with a newly installed and commissioned combined heat and power station. **Eawag** was able to commission the new FLUX building at the Dübendorf site in summer 2021. It contains biology and chemistry laboratories, including the laboratory for training apprentices, and offices, meeting rooms, placement rooms and classrooms. Work continued on the planned replacement new build with office, laboratory and storage spaces (Limnion project) on the Kastanienbaum site.

Investments and source of funds in 2021

The 2021 investment credit for buildings in the ETH Domain amounted to CHF 226.75m. In 2021, despite uncertainties due to the pandemic, there was no credit reallocation between the investment credit and the federal financial contribution, and no new dedicated reserves were created. The investment credit was well below the previous year's value (CHF 271.03m) and thus again close to the long-term average.

Some 48.1% of the investments were accounted for by new buildings and 51.9% by preserving value and functionality. No third-party funds were used for federal real estate (co-financing). CHF 108.6m was used from the Federal Government's financial contributions for investments in user-specific operating facilities which will be owned by the institutions. These investments were supplemented by third-party funding of CHF 2.3m. The total volume of construction authorised by the ETH Domain in 2021 amounted to CHF 337.7m (see Fig. 29, p. 105). The ETH Domain received an accommodation loan of CHF 230.2m in 2021 for the calculated rent on the state-owned real estate. The Source of Funds chart (see Fig. 24, p. 103) shows the sources of funds for the buildings in the ETH Domain since 2012. The annual fluctuations depend on the grant and the scope of the construction projects.

CP 2022: one major project at ETH Zurich

In the case of new construction projects planned or new builds, extensions or refurbishments, the ETH Domain applied for the necessary contingent credit with its annual construction programme (CP). The 2022 construction programme for a total of CHF 315.7m (total credit), approved by the Federal Parliament on 16 December 2021, includes the following major project: ETH Zurich applied for a contingent credit of CHF 209.7m for the construction of the new HPQ physics building on the Hönggerberg campus. One focus of the Department of Physics is the investigation of physical phenomena, such as quantum effects, which can now be examined under special conditions on previously unattainably small long and short time-scales. This forms a basis for future technologies and completely new types of materials (see also p. 15). To expand this research and be prepared for future challenges, a new HPQ physics building is to be built on the Hönggerberg site. Besides modern, flexibly designed laboratories

and office spaces, the new building should also enable cross-departmental technology platforms for nano-technology and the production of new types of materials in high-performance laboratories with perfect shielding against external influences. A credit line of CHF 106m has been requested for 2022. Credit lines make it possible to carry out construction projects costing for CHF 10m, and to plan projects over CHF 10m.

Maintaining value and functionality

The ETH Board is legally obliged to maintain the value and functionality of the properties of the ETH Domain. This is in the interests of the Federal Government as the owner and of the ETH Domain as the user. Despite the advanced age of some of the buildings and their intensive use, the state value of around 82% determined in 2021 remains high in relation to the new value (see Fig. 25, p. 103). The refurbishment work on historical buildings is considerable in some cases, leading to challenging projects. Renovation projects above CHF 711.6m are currently included in the 2022–2025 real estate investment plan. They triggered an investment volume of some CHF 117.8m in 2021. In addition, ongoing maintenance work amounting to some CHF 50m was funded from the state financial contribution. Consequently, the ETH Domain demonstrated that it is using the building stock provided by the Federal Government responsibly and sustainably.

Coordination tasks

In 2021, too, the Real Estate department of the ETH Board coordinated the interests of the institutions of the ETH Domain with those of the government agencies in the development of standards and guidelines for the planning, realisation and operation of real estate. This coordination takes place with the participation of the institutions and also includes their co-determination and active involvement in this process. The most important topic was elements of structural reforms. In particular, these are a strategy for digitalisation in the construction sector (BIM method) and a control system for economic use of spaces. In the field of sustainability, the Real Estate department not only coordinated, but also shaped various working groups on topics such as building culture, life cycle costing, energy and the environment (pursuant to the Exemplary Energy and Climate initiative, EEC). The ETH Board is also a member of the commission of the Office for University Buildings (FHB) for the University Council of the Swiss University Conference. This involves determining the Federal Government's building investment and use contributions.

Governance

With the decision of the ETH Board, the minimum standards for managing construction projects in the ETH Domain entered into force as of January 2021. The institutions are applying the new control instruments and approval and reporting system, and have already gained some experience. The clarification of the process and its simplification are highly appreciated and are intended to further increase the quality of the construction projects. The staff of the ETH Board, together with the six institutions, drew up the periodic reports on risk management and the internal control system (ICS) in real estate management. The associated improvement process and measures introduced prove a careful handling of the Federal Government's real estate that has been made available for use. In 2021, two audits were carried out almost simultaneously by the Swiss Federal Audit Office (SFAO). These affected the real estate management process between the Federal Office for Buildings and Logistics (FOBL) and the ETH Domain as a part of the federal calculation (focussed on the ICS effectiveness) as well as the supervision of the ETH Board in real estate management. During another audit, in which the ETH Board was not being audited, it was included in its role as a building and real estate body (BLO) within the scope of "ERP real estate" (Release upgrade SAP 4HANA). The audit reports are expected at the start of 2022. With the partial resumption of operations in 2021, the result of the Swiss-Tech Convention Center (STCC) could be improved somewhat compared to the de facto total loss of major events in 2020. Discussions between EPFL and the ETH Board with the investor to find solutions to improve the long-term financial outlook progressed quickly. With the amendment of the ETH Act, the ETH Domain was given the power to rent spaces and supply excess energy to third parties. The Financial Ordinance stipulates that 90% of revenue from the transfer of use (rentals), which is not made within the scope of the

Strategic real estate management in the ETH Domain

Efficient building infrastructure is a central requirement for enabling both Federal Institutes of Technology and the four research institutes to achieve their targets in teaching and research and to meet the required quality standards. The real estate of the ETH Domain is owned by the Federal Government. The investment credit for construction is earmarked annually in the budget. It appears in the state accounts under the Federal Department of Finance (specifically the Federal Office for Buildings and Logistics, FOBL). As one of the Federal Government's three building and real estate authorities, the ETH Board assumes the ownership role in trust. It is responsible for the real estate portfolio of the ETH Domain and consults the institutions on strategic real estate management in order to ensure the functionality of the real estate portfolio in the medium and long term and to preserve its cultural value. Needs-based planning, and the timely realisation of new construction projects, conversions and refurbishments, are at the heart of its remit. The preservation of value and functionality is the result of needs-based planning, geared – also in the interests of the owner – towards cost/benefit considerations, as well as corresponding controlling at ETH Board level. The owner is kept abreast of this by way of reports from the ETH Board. The ETH Domain is committed to the sustainable development of its real estate portfolio and thus to sustainable real estate management. It does so in compliance with the Federal Council mandate under Art. 73 of the Federal Constitution, as well as the Federal Government's strategy for sustainability and climate/energy strategy.

fulfilment of duties and the strategic objectives, must be paid to the Federal Government by the institutions. This occurred for the first time in 2021, and the ETH Board has the task of verifying the application of the criteria. When selling excess energy to third parties, the same levy on gross revenue was therefore decided. This also affects Empa's "move" research project in the field of hydrogen.

Sustainability: environment and energy

The focus was the implementation of the "Climate Package", passed by the Federal Council in 2019, stipulating that the Federal Administration should become climate-neutral by 2030. Thus the climate package obliges the ETH Domain to reduce annual greenhouse gas emissions by 50% compared to the starting year of 2006. The remaining emissions must be fully offset with reduction certificates by 2030. Thanks to measures already planned in advance, such as the anergy grid on the ETH Zurich Hönggerberg campus to replace fossil fuels for heating buildings and to procure electricity from hydropower, the institutions of the ETH Domain are well on track to meet these goals.

With regard to the obligation to offset **CO_2 emissions**, a concept was created for taking into account own projects. The pandemic will also have a short- and long-term impact on the environment and energy. It should be noted that the energy consumption of the buildings has not fallen significantly, as might have been expected. This is due to more stringent requirements for air exchange rates and the proportion of fresh air in the buildings despite the smaller number of users. In addition to employees partially working from home, the transfer of courses to online events is the biggest change in terms of on-campus presence. The impact of the pandemic is reflected in an impressive manner in the figures on the use of video conferencing tools.

In terms of **mobility**, as expected there was a further major decrease in commuter and air traffic, which considerably reduced CO_2 emissions. Due to the pandemic, there were virtually no more work-related flights and business trips. In the catering sector, too, less energy was consumed as a result.

ETH Zurich is now implementing a cooling network with the use of waste heat on its Zentrum campus. Other notable projects include savings from the use of partial-circulation laboratory fume hoods, and the annual reduction in diesel consumption of 70,000 litres thanks to the use of e-buses for the ETH eLink shuttle service. A sustainability programme for the catering sector on the ETH Zurich site, which is to start in 2022, and the preparation of a white paper "Net Zero Implementation" are in the preparation or planning phase. **EPFL** was able to commission the new energy centre with lake water for heating with a heat pump and direct cooling, and heat utilisation from the data centre which will be located above it. In addition, a revision of the directives on business and student trips is underway to reduce the impact of air travel.

In 2021, ProKilowatt awarded the **PSI** a grant for the installation of new permanent magnets at SLS 2.0, which will lead to energy savings of around 2.9 GWh per year. A further application was submitted for the replacement of the river Aare water pumps with energy savings of 1.1 GWh per year. Examples of successful flagship projects in the PSI's environmental and energy research are the Ice Memory mission, studies on health risks from particulate emissions, development of the Carculator open source tool for the life cycle analysis of passenger cars, the launch of the SynFuel project for the production of aircraft fuels from renewable resources together with Empa and the launch of the SURE project (SUstainable and REsilient energy for Switzerland), which is funded by the SFOE, with the PSI as leading house. With the opening of the new multi-functional FLUX building in August 2021, which is Minergie-ECO® certified, **Eawag**'s energy reference area and its energy requirements have increased slightly. Thanks to the planned commissioning of a geothermal probe as a seasonal heat storage facility in 2023 and further efforts in energy efficiency, the total energy requirements of **Empa** and **Eawag** are to be further reduced. Eawag expects that the regulation with the slogan "We don't fly under 1,000 km" will keep the flights after the pandemic at a lower level than before. **WSL** started with the call for tenders (according to SIA 142) for a replacement new build in Birmensdorf, which is certified according to Minergie-P ECO. In Davos, a replacement new build is currently also being carried out, which is the first of the ETH Domain to be certified according to the Sustainable Building Standard Switzerland (SNBS).

In 2021, the institutions' activities were also embedded in national programmes, such as Energy Agency of the Swiss Private Sector (EnAW), the Federal Government's Climate Package or the "Exemplary Energy and Climate initiative" (VBE) for the period 2021–2030. ETH Zurich's EnAW target agreement, for example, requires that energy efficiency be increased by 2% per year. Since 2014, the ETH Domain has been involved in the Federal Government's VBE initiative. Phase 1 of VBE has been completed, and the target of a 25% increase in efficiency compared to the base year 2006 was exceeded at around 31%. For phase 2, additional efficiency gains of 9% by 2030 are planned.

Strategic objective

WORKING CONDITIONS, EQUAL OPPORTUNITIES & YOUNG SCIENTISTS

Respect, diversity and inclusion, as well as leadership and the development of overarching competencies, shaped the HR policy in 2021. Through respect campaigns, leadership development and the acceleration of "new ways of working", the most varied of measures on these issues were implemented in all institutions.

Executive promotion and management development

ETH Zurich focused on expanding leadership opportunities for professors as well as for line managers in scientific and administrative technical functions, in order to deal with issues relating to leadership, cooperation, culture, communication and conflict management. Amongst other things, it created the "Fit for my new leadership role" programme. There are also opportunities for scientific staff (senior scientists or MER) to develop further in the ETH Domain and the profiles include regular evaluation and development meetings. For example, the consultation procedure of the adapted profiles of postdocs and research associates was completed at ETH Zurich in 2021. The "Lateral Leadership – Influencing others without having a leadership position" course is aimed specifically at scientific personnel without formal leadership duties. EPFL launched individual support opportunities through coaching and mentoring, as well as various campaigns and working groups on expanding the culture of respect, preventing harassment and research integrity. The comprehensive digital and face-to-face development programme is constantly being developed, is tailored to the needs of each individual and comprises all hierarchical levels. It also expanded leadership training for new postdocs. The two-day seminar in Ittingen for the top two management levels, in which both leadership topics and strategic focal points for the coming years were dealt with, specifically served the development of the strategy and senior management structure at the PSI. The further development of the training of all managers and experts continues to be carried out as a joint venture with FHNW (University of Applied Sciences and Arts Northwestern Switzerland) and the research institutions Empa, Eawag and WSL as part of the CAS "Leadership in Science". Empa supplements this basic training with its own seminars for middle and upper management. WSL conceptualised leadership training for middle management, conducted a pilot course for group leaders and supported individual training courses – just like Empa and Eawag did. Doctoral students and postdocs benefit from various specific courses on planning their professional career. For example, at Empa, a specialist career is equal to a management career and extends up to the level of "Distinguished Senior Researcher". To support the senior managers, regulations on agility and virtual collaboration have been revised and updated. In addition to the "CAS Leadership in Science", Eawag held events for managers and workshops for doctoral students as well as providing-training opportunities to postdocs. Mentoring programmes, lateral leadership courses for project managers and career planning at all levels rounded off the offer.

Training young scientists

The **ETH Zurich** Career Center offers students and doctoral students comprehensive support in planning their careers. A "Career Week" was organised for post-

docs in which they were able to deal with issues relating to their further career by taking advantage of a wide range of opportunities to obtain information and exchange views. Various fields of action in the area of a healthy work-life balance, giving due consideration to parenthood and offers of development and support were defined and implemented. **EPFL** also extended individual support for young scientists through coaching, mentoring, digital and face-to-face training, as well as various campaigns and working groups. The EPFL Career Center has been expanded and it has been possible to raise awareness among doctoral students and postdocs of scientific activities in the economy. At the **PSI**, it was about continuous awareness-raising of career planning through events of the PSI Career Center and the successful conclusion of the pilot phase of the "CONNECT" cooperation project which is being carried out with all institutions of the ETH Domain and the University of Zurich. The pilot phase also included video interviews which convey role models' knowledge of the private sector to young researchers. Postdocs, whose employment contract with the PSI expired, were helped by individual inter-institutional arrangements, provided that they were unable to take up their new position due to the pandemic. **WSL** carried out a full evaluation of all offers and will develop a comprehensive concept to promote early career scientists. In addition, doctoral students at WSL have access to the online courses "Scientific Writing and Publishing" as part of the "nature masterclasses" of Springer Nature. In addition, there are regular networking activities such as coffee breaks as well as various courses including "Self-Management" (for doctoral students) and "Effective Grant Writing" (for postdocs). Another focus was on the maintenance of the alumnae networks. The popular **Empa** summer camp for children of primary school age to promote an interest in natural and engineering sciences, as well as the national future day, were also carried out in 2021 with corresponding restrictions due to the pandemic. **Eawag** organised courses on various topics: presenting/publishing, "Writing English for Science", media training for researchers, social media/online communication training, troubleshooting, career development and individual support for realignment processes.

Promotion of equal opportunities and diversity

In surveys, the ETH Domain is perceived as a respectful and diverse working environment due to the ongoing commitment of the universities and research institutes. Diversity and inclusion are regularly addressed in all institutions and internal measures are published. All job advertisements are also formulated in accordance with diversity and inclusion guidelines. In order to combat bullying, discrimination and harassment, the code of conduct is regularly addressed and corresponding training provided – both in the case of new employees and in management training courses. In addition, there are various advisory and ombuds offices throughout the ETH Domain.

At the end of October 2021, **ETH Zurich** launched the 2021 Respect Campaign under the slogan of "Put a full stop. When others don't. Stand up for respect.". At 25 events, relatives and experts were able to exchange views on various topics relating to a respectful and diverse culture. Additional discussions on values and culture focused on responsibility, openness, team spirit, diversity and excellence and what these mean for everyday tasks in working groups, teams and committees. In order to implement the future "Respect@EPFL" system, **EPFL** established a cross-sectoral trust and support network to strengthen prevention, to address victims and witnesses of discrimination, harassment or violence, to refer them to the appropriate internal or external services, and to propose and implement de-escalation measures. The results of EPFL's "Task Force Harassment A-Z" led to a realignment and strengthening of the current "Respect" structures, which introduce and ensure prevention and support measures so that situations are dealt with the utmost care. Through the establishment of the joint Center of Competence for Diversity & Inclusion and the involvement of the Committee for Equal Opportunities, the **PSI**, **Empa** and **Eawag** ensure a regular exchange of views, the use of synergies and reporting to the directorates. The PSI published diversity guidelines and developed the action plan entitled "Equal opportunities, diversity and inclusion 2021-2024". WSL revised its Gender Action Plan, expanded its conflict management system, developed a concept for early detection of problematic situations and initiated the founding meeting of its TechNet. Empa has won several awards for its deep-rooted, trust-based management and corporate culture and has several independent ombuds offices for people who feel disadvantaged or discriminated against. Eawag's EOC Committee (Equal Opportunities Committee), consisting of employees from all groups, is committed to equal opportunities and gender issues.

Increasing the proportion of women in teaching and research

The proportion of women in teaching and research is continuously increasing throughout the ETH Domain, especially in management positions and professorships; care is taken to ensure that strategic committees are diverse, such as the two universities' tenure committees and other advisory committees. In the case of appeal proceedings at the two Federal Institutes of Technology, the representation of women professors on appeals committees is clearly defined and women candidates must be recommended for appointment. In the ETH Domain, there is a Gender/Diversity Advocate, dual career advice and the "Fix the Leaky Pipeline Programme", which offers young female scientists from all six institutions of the ETH Domain support in their careers. Numerous professors took part in the High Potential University Leaders Identity & Skills Training

Program (H.I.T.) and the Gender Sensitive Leaders in Academia programme. The equal pay analysis carried out in 2020 at all the institutions of the ETH Domain in accordance with the Gender Equality Act (GEA) has confirmed that all the institutions of the ETH Domain pay the same wages to men and women. At Eawag, the gender coefficient benchmark (gender pay differences) was even in favour of women.

New divisions have been created at management level at both **ETH Zurich** and **EPFL**, and the proportion of women has increased. The leadership training for professors and other leaders also covers the topics of diversity and integration. Since 2020, **EPFL** has been offering a targeted programme of courses on gender-neutral language. At the **PSI**, in 2021, increasing the proportion of women in leadership roles was a strategic priority topic at a two-day seminar for the top two management levels. In addition, the following measures have been taken to attract new staff: Smart Staffing@PSI, a pilot project in collaboration with Witty Works on diversity-promoting job advertisements, intensification of employer branding, leadership training on unconscious bias as well as the expansion of flexible working conditions and the creation of new mentoring programmes. **WSL** expanded its Gender Action Plan to include measures such as parent coaching. The successful Women's Peer Mentoring Group is now in its third year and a mentoring programme for women scientists is currently being developed. WSL also offered self-marketing and negotiation courses for female scientists. **Empa** promoted the interest of girls in STEM professions and increased the proportion of women in the apprenticeship trades. Empa and Eawag are members of "Advance", which offers webinars on increasing the proportion of women in leadership positions. **Eawag** also systematically promotes women's career prospects through promotion and flexible employment levels and forms of work.

Training apprentices

Particular attention is paid to interdisciplinarity and networking where apprentices are concerned. Social, methodical and personal skills through teamwork, customer contact and entrepreneurial project work lead time and again to outstanding results at the research institutes too as excellent training companies with very good apprenticeship qualifications. The institutions of the ETH Domain offer apprenticeships for young people with disabilities or with a less educated background. To promote educational opportunities and contribute to inclusion, training posts for the pre-apprenticeship pilot programme to support integration (Invol) are offered to enable refugees to enter the vocational education and training (VET) programme.

ETH Zurich will increase its 170 apprenticeships in 15 occupations by 20% (+35 apprenticeships) in the coming years. The establishment of a central training unit is planned for basic commercial education and training. The newly founded "Young 'n' Rising" brings together apprentices in interdisciplinary projects for the optimisation of processes and systems and supports them with the learning platform "Lern mit mir" (Learn

Respect@EPFL, a cross-sectoral trust and support network to strengthen prevention and address victims and witnesses of discrimination, and harassment or violence.
› EPFL

with me). With Apprenticeship Prospects 2020, **EPFL** conducted a campaign to create apprenticeships for apprentices who had lost their apprenticeship due to the pandemic and increased their total number of apprenticeships by 5% to 109. The **PSI** is currently training 105 apprentices in 15 professions, who win awards on a regular basis, including the "Pestalozzi Stiftepriis" (apprenticeship prize) which, as the best degree in information technology in the Canton of Aargau, was awarded to 28 PSI graduate apprentices, and a silver medal at EuroSkills 2021 in Graz including admission to the WorldSkills in Shanghai in 2022. **WSL** is supporting and training 13 apprentices in eight professions in Birmensdorf and Davos. According to an independent market research institute, **Empa** is considered the best employer in Switzerland in 2021 in the category of "Education and Research" and has held the title of "A great place to work" for many years. It is training more than 40 apprentices in ten different professions. **Eawag** is training 25 apprentices in four professions.

Professional integration

For several years, the institutions of the ETH Domain have been employing people with restrictions on their ability to work and perform. In the case of employees with temporary or permanent performance restrictions, their retention in the employment process is a priority. If this is unsuccessful, these employees will be intensively assisted to reorientate themselves in a structured process.

ETH Zurich has continuously expanded case management to support line managers and employees in long-term absences and reintegration, achieving a high success rate. It also launched the barrier-free project: in the coming years, people with special needs will have largely unrestricted access to the buildings and services of ETH Zurich. The research institutes **PSI**, **WSL**, **Empa** and **Eawag**, in collaboration with social insurance companies and reintegration companies, offer work tests for professional reintegration, which lead to permanent positions on a regular basis. **WSL** and **PSI** enabled various work tests for reintegration and employees with reduced physical and mental performance were supported in the workplace in cooperation with trained job coaches. **Empa** has enshrined in its HR policy that the employment of people with physical or mental impairments is made possible by taking appropriate individual measures. **Eawag** works closely with invalidity insurance (IV) offices. Work tests were performed, and changes in the workplace and employment level adjustments have been implemented.

Domestic labour force potential

The corresponding statutory criteria and recommendations are complied with and implemented throughout the ETH Domain in the recruitment of new employees. Vacancies in the administrative and technical fields that are covered by the relevant ordinance are reported to the regional employment agencies (RAV) and are advertised on Swiss job sites.

Conclusion, outlook and objectives

At both universities, the course was set for organisational further development in the digital age and ensuring competitiveness by means of the projects "rETHink" and "The Future of Work@EPFL", with the involvement of university members. The research institutes also systematically strengthened their strategic and operational leadership by working together internally and maintaining values at all levels. The "lifelong-learning approach" shows that digital skills and leadership topics are becoming increasingly important. Diversity strategies are developed and put into practice, whilst mobile forms of work are implemented and encouraged. Line managers and employees are trained, supported and assisted in a targeted manner thanks to the commitment of excellently trained, service-oriented specialists in the HR departments.

Key personnel figures 2021

On 31 December 2021, the headcount in the ETH Domain stood at 24,268 employment contracts (ECs), or 20,533.8 full-time equivalents (FTEs) (see Fig. 17, p. 100). The headcount increased by 796 ECs (+3.4%) or 416.8 FTEs compared to the previous year. Although the growth in headcount was slightly less than in the previous year, it was still a little above the usual values of between 2% and 3%. The lion's share of personnel growth can be attributed to ETH Zurich, which employed more scientific personnel.

Scientific personnel, including doctoral students, remains the largest employee category in the ETH Domain, with 14,789 ECs (12,277.4 FTEs) (60.9% of the total headcount, see Fig. 17, p. 100), followed by technical staff, which accounts for 4,102 ECs (3,722.3 FTEs) or 16.9% of the headcount. 16.6% of all employees or 4,025 ECs (3,214.9 FTEs) are administrative employees and 1.9% are apprentices. Like in the previous year, professors account for 887 ECs (854.6 FTEs) or 3.7% of the total headcount.

Professors
In 2021, ETH Zurich and EPFL employed a total of 710 full and associate professors: in addition, they employed 130 assistant professors with tenure track (TT) and 47 assistant professors without TT (see Fig. 18, p. 100).

The proportion of women in these three categories grew from 18.5% to 19.8% in 2021. The figures were 16.2% for full and associate professors, 33.8% for assistant professors with TT and 36.2% for assistant professors without TT.

In 2021, 67% of the total of 887 professors came from abroad (2020: 66.9%). Of these, 47.8% (2020: 48%) came from the EU area and 19.2% from other countries (2020: 18.9%) (see Fig. 18, p. 101).

Financing the professorships
Of the 548 professors (525.8 FTEs) employed at ETH Zurich as of 31 December 2021, 465.3 FTEs (88.5%) were financed by the total federal contribution, 15.9 FTEs (3.1%) by SNSF, 10.4 FTEs (2%) by EU research programmes, and 33.4 FTEs (6.4%) by third-party financial research contributions, as well as by donations and bequests.

Of the 339 professors (328.8 FTEs) employed at EPFL as of 31 December 2021, 312.7 FTEs (95.1%) were financed by the total federal contribution, 2.5 FTEs by the SNSF and by Innosuisse (0.8%), 1.4 posts (0.2%) by special federal funding of applied research and EU research programmes, and 12.2 FTEs (3.8%) by third-party financial research contributions, as well as by donations and bequests.

Proportion of women
The proportion of women in the ETH Domain increased in 2021 to 35.9% (2020: 35.4%), although it varies according to institution, role and discipline. (see Fig. 22, p. 102).

The proportion of women in managerial positions (from function level 10) rose to 22.7% (2020: 21.6%). The two universities, WSL and Eawag, made a significant contribution to achieving this good result.

Apprentices
In the reporting period, the ETH Domain offered 465 apprentices an apprenticeship in more than 20 different career paths. Women accounted for 31% of apprentices in 2021.

KEY FIGURES

Monitoring table on the strategic objectives by the Federal Council

Fig. 3: Monitoring table on the strategic objectives set by the Federal Council for the ETH Domain for 2021–2024

	Reference values			Monitoring
Indicators	2013	2017	2020	2021
TEACHING				
Students and doctoral students ETH Zurich and EPFL (headcount)				
New admissions				
At Bachelor's level	5,255	4,756	5,245	5,218
Students[1]	**22,099**	**25,059**	**28,637**	**29,243**
Proportion of women (%)	29.1	30.6	31.7	31.9
Proportion of foreign nationals (%)	35.5	38.4	40.7	40.9
At Bachelor's level[1]	13,995	14,385	15,983	16,650
Proportion of women (%)	28.6	30.6	32.0	32.5
Proportion of foreign nationals (%)	30.9	29.4	32.6	34.1
At Master's level[1]	7,241	8,895	11,143	11,741
Proportion of women (%)	29.4	29.4	30.3	30.4
Proportion of foreign nationals (%)	43.1	45.4	48.4	50.0
On MAS / MBA programmes	863	840	816	852
Proportion of women (%)	34.6	38.8	42.6	42.1
Proportion of foreign nationals (%)	45.7	51.5	47.7	48.5
Visiting students (incoming)[1]	–	939	695	–
Proportion of women (%)	–	35.5	33.7	–
Proportion of foreign nationals (%)	–	96.5	95.0	–
Supervision ratio				
Bachelor's and Master's students per professor	27.7	28.3	31.7	33.2
Doctoral students	**5,947**	**6,234**	**6,598**	**6,867**
Proportion of women (%)	30.4	30.8	33.6	33.9
Proportion of foreign nationals (%)	72.6	75.0	78.1	78.6
Supervision ratio				
Doctoral students per professor	7.7	7.6	7.7	8.0
Students and doctoral students[1]	**28,046**	**31,293**	**35,235**	**36,110**
Proportion of women (%)	29.4	30.6	32.0	32.3
Proportion of foreign nationals (%)	43.3	45.7	47.7	48.1
Supervision ratio				
Students and doctoral students per professor	36.5	38.0	41.2	42.3
Degrees				
Bachelor	2,249	2,602	3,007	3,213
Diploma, Master	2,663	3,065	3,344	3,898
MAS / MBA	346	394	249	304
Doctorate	993	1,258	1,171	1,257
Teaching and supervision by the research institutes				
Teaching hours	15,670	17,992	18,553	19,305
Bachelor's, Master's and Diploma projects	532	602	608	736
Doctoral students	797	807	842	872
Proportion of women (%)	36.3	39.0	39.9	39.0
Proportion enrolled in the ETH Domain (%)	67.9	67.7	70.3	70.8
Proportion enrolled at a foreign university (%)	13.4	10.3	9.1	11.0

RESEARCH				
Publications[2]	**–**	**–**	**–**	**–**
Research contributions, mandates and scientific services (in CHF millions)	**–**	**743.2**	**774.1**	**787.7**
of which Swiss National Science Foundation (SNSF)	209.0	260.3	262.6	267.8
of which Innosuisse	36.8	62.6	50.6	41.3
of which EU Framework Programmes for Research and Innovation (EU-FP)	135.2	139.2	146.4	160.2
KNOWLEDGE AND TECHNOLOGY TRANSFER (KTT)				
Invention disclosures[3]	–	343	310	330
Software notifications[3,4]	–	26	32	39
Patents	193	206	217	213
Licences[5]	223	377	338	181
Spin-offs	43	48	66	60
STAFF (FTE)				
Professors	767.7	823.8	854.6	854.6
Proportion of women (%)	12.4	14.8	18.6	20.0
Proportion of foreign nationals (%)	67.1	67.2	67.3	67.7
Scientific staff	9,927.3	11,204.4	11,994.6	12,277.4
Technical staff	3,157.3	3,439.8	3,676.3	3,722.3
Administrative staff	2,279.0	2,690.0	3,118.9	3,214.9
Apprentices	435.0	473.6	472.6	464.6
FINANCES/REAL ESTATE				
Total federal contribution (expenditure ceiling perspective) (in CHF million)	**2,271.4**	**2,530.8**	**2,596.1**	**2,600.1**
of which federal financial contribution	2,073.9	2,377.9	2,355.1	2,373.3
of which investment credit for construction in the ETH Domain	197.5	152.9	241.0	226.8

1 Until 2016, visiting students (incoming) were counted yearly in the numbers of students at Bachelor's and Master's levels. In 2017–2020, visiting students were reported yearly as a separate student category and counted in the total number of students. Since 2021, visiting students are reported per semester in a separate table (see Fig. 11, p. 96) and are no longer counted in the total number of students. Without this modification, ETH Zurich and EPFL would have counted a total of 30,294 in 2021.
2 Publishing activity is assessed every four years as part of the intermediate evaluation.
3 Additional KTT indicators introduced in 2017.
4 Open source software not included.
5 The definition of licences was revised in 2021. This category no longer includes contracts with prior IP transfer and contracts for software licences of less than CHF 1,000. This should be taken into account when comparing with the figures for previous years. Without this change, the total number of licences would have been 406 in 2021.

Indicators and counting methods for the monitoring table and the academic achievement report

If not specified in more detail, the term "students" is always understood to mean students at Bachelor's and Master's levels, as well as students on Master of Advanced Studies and Master of Business Administration (MAS/MBA) continuing education programmes. Doctoral students are defined as a separate category. Students and doctoral students are counted in numbers of persons (headcount). These figures may differ from those which ETH Zurich and EPFL enter in their respective annual reports, as there are different counting methods.

Since 2021, exchange students are no longer included in the total number of students. Incoming exchange students (students who are enrolled at another university and study for at least three months or 20 ECTS at one of the two Federal Institutes of Technology) and outgoing exchange students (students who are enrolled at one of the two Federal Institutes of Technology and study for at least three months or 20 ECTS at another university) are now listed in a separate table for each semester. Foreign students and doctoral students form two sub-categories: foreign-educated foreign nationals who were resident abroad while obtaining the relevant necessary qualifications, and Swiss-educated foreign nationals who were resident in Switzerland while obtaining the relevant necessary qualifications.

The employment level of all staff is counted in terms of full-time equivalents (FTE). Professors, both full and associate, as well as assistant professors, including those recipients of the Swiss National Science Foundation (SNSF) Eccellenza professorial fellowship who are employed at one of the two Federal Institutes of Technology, are taken into account in calculating the supervision ratio. Senior scientists and *Maîtres d'enseignement et de recherche* (MER) from both Federal Institutes of Technology correspond to the academic staff in management roles or senior management staff. Some of them are adjunct professors. To determine the "expanded" supervision ratio, the Senior Scientists and MER of both Federal Institutes of Technology are added to the professors. The teaching hours delivered by the research institutes do not include preparation time, only the time spent in the presence of students.

Academic achievement report

Fig. 4: Students and doctoral students by discipline

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Architecture	**3,177**	**3,097**	**3,066**	**3,060**	**3,030**	**3,047**	**3,041**	**3,090**	**3,035**	**3,169**
ETH Zurich	1,950	1,852	1,783	1,805	1,771	1,823	1,855	1,904	1,923	2,031
EPFL	1,227	1,245	1,283	1,255	1,259	1,224	1,186	1,186	1,112	1,138
Civil and Geomatic Engineering	**2,900**	**3,074**	**2,946**	**2,882**	**2,860**	**2,791**	**2,777**	**2,716**	**2,700**	**2,641**
ETH Zurich	1,629	1,740	1,731	1,716	1,701	1,688	1,667	1,614	1,646	1,606
EPFL	1,271	1,334	1,215	1,166	1,159	1,103	1,110	1,102	1,054	1,035
Engineering Sciences	**6,816**	**7,245**	**7,502**	**7,903**	**8,069**	**8,398**	**8,699**	**9,081**	**9,577**	**9,795**
ETH Zurich	4,341	4,549	4,729	4,930	4,993	5,135	5,224	5,467	5,851	6,053
EPFL	2,475	2,696	2,773	2,973	3,076	3,263	3,475	3,614	3,726	3,742
Information and Communications Technology	**2,367**	**2,536**	**2,665**	**2,809**	**3,033**	**3,261**	**3,648**	**4,031**	**4,529**	**4,929**
ETH Zurich	1,083	1,158	1,247	1,405	1,536	1,753	1,991	2,246	2,560	2,776
EPFL	1,284	1,378	1,418	1,404	1,497	1,508	1,657	1,785	1,969	2,153
Exact and Natural Sciences	**4,780**	**4,883**	**4,944**	**5,145**	**5,442**	**5,595**	**5,810**	**5,940**	**6,290**	**6,412**
ETH Zurich	2,903	2,972	3,024	3,157	3,352	3,505	3,691	3,794	4,039	4,063
EPFL	1,877	1,911	1,920	1,988	2,090	2,090	2,119	2,146	2,251	2,349
Human Medicine[1]	**–**	**–**	**–**	**–**	**–**	**99**	**192**	**286**	**296**	**311**
ETH Zurich	–	–	–	–	–	99	192	286	296	311
Life Sciences	**3,708**	**3,879**	**3,990**	**4,051**	**4,216**	**4,312**	**4,500**	**4,624**	**4,859**	**4,864**
ETH Zurich	2,823	2,923	3,012	3,044	3,162	3,218	3,326	3,433	3,566	3,595
EPFL	885	956	978	1,007	1,054	1,094	1,174	1,191	1,293	1,269
System-oriented Natural Sciences	**2,201**	**2,159**	**2,211**	**2,284**	**2,411**	**2,437**	**2,520**	**2,538**	**2,569**	**2,542**
ETH Zurich	2,201	2,159	2,211	2,284	2,411	2,437	2,520	2,538	2,569	2,542
Management, Technology, Economics	**870**	**897**	**913**	**913**	**972**	**973**	**966**	**954**	**937**	**962**
ETH Zurich	583	549	579	582	571	583	573	560	566	571
EPFL	287	348	334	331	401	390	393	394	371	391
Humanities, Social and Political Sciences[2]	**268**	**276**	**300**	**310**	**318**	**380**	**378**	**382**	**443**	**485**
ETH Zurich	268	276	300	310	318	366	358	351	406	435
EPFL	–	–	–	–	–	14	20	31	37	50
Total students and doctoral students	**27,087**	**28,046**	**28,537**	**29,357**	**30,351**	**31,293**	**32,531**	**33,642**	**35,235**	**36,110**
ETH Zurich	17,781	18,178	18,616	19,233	19,815	20,607	21,397	22,193	23,422	23,983
EPFL	9,306	9,868	9,921	10,124	10,536	10,686	11,134	11,449	11,813	12,127
Women	**7,973**	**8,238**	**8,414**	**8,677**	**9,091**	**9,587**	**10,167**	**10,675**	**11,280**	**11,660**
ETH Zurich	5,445	5,560	5,701	5,873	6,164	6,563	6,917	7,304	7,768	7,995
EPFL	2,528	2,678	2,713	2,804	2,927	3,024	3,250	3,371	3,512	3,665
Foreign nationals	**11,437**	**12,152**	**12,354**	**12,804**	**13,615**	**14,290**	**15,160**	**15,993**	**16,799**	**17,368**
ETH Zurich	6,559	6,751	6,949	7,226	7,563	7,972	8,433	8,876	9,438	9,808
EPFL	4,878	5,401	5,405	5,578	6,052	6,318	6,727	7,117	7,361	7,560

Since 2021, visiting students are no longer being counted in the student totals.
This should be taken into account when comparing figures from previous years.

[1] ETH Zurich introduced a Bachelor's degree in Human Medicine in 2017.
[2] EPFL introduced a Master's degree in Digital Humanities in 2017.

Fig. 5: Students and doctoral students by academic level

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Δ 2020 / 2021	
												in %
Bachelor's programmes	**13,359**	**13,995**	**13,944**	**14,292**	**14,727**	**14,385**	**14,792**	**15,243**	**15,983**	**16,650**	**667**	**4.2**
ETH Zurich	8,468	8,817	8,820	9,087	9,309	9,262	9,517	9,895	10,355	10,642	287	2.8
EPFL	4,891	5,178	5,124	5,205	5,418	5,123	5,275	5,348	5,628	6,008	380	6.8
Master's programmes	**6,981**	**7,241**	**7,781**	**8,126**	**8,662**	**8,895**	**9,517**	**10,163**	**11,143**	**11,741**	**598**	**5.4**
ETH Zurich	4,755	4,811	5,187	5,480	5,861	6,158	6,590	7,037	7,790	8,206	416	5.3
EPFL	2,226	2,430	2,594	2,646	2,801	2,737	2,927	3,126	3,353	3,535	182	5.4
MAS / MBA	**911**	**863**	**805**	**836**	**828**	**840**	**827**	**809**	**816**	**852**	**36**	**4.4**
ETH Zurich	763	661	634	640	635	646	635	626	644	675	31	4.8
EPFL	148	202	171	196	193	194	192	183	172	177	5	2.9
Visiting students (incoming)[1]	**–**	**–**	**–**	**–**	**–**	**939**	**1,004**	**1,060**	**695**	**–**	**–**	**–**
ETH Zurich	–	–	–	–	–	449	480	467	317	–	–	–
EPFL	–	–	–	–	–	490	524	593	378	–	–	–
Total number of students[1]	**21,251**	**22,099**	**22,530**	**23,254**	**24,217**	**25,059**	**26,140**	**27,275**	**28,637**	**29,243**	**–**	**–**
ETH Zurich	13,986	14,289	14,641	15,207	15,805	16,515	17,222	18,025	19,106	19,523	–	–
EPFL	7,265	7,810	7,889	8,047	8,412	8,544	8,918	9,250	9,531	9,720	–	–
Doctoral programmes	**5,836**	**5,947**	**6,007**	**6,103**	**6,134**	**6,234**	**6,391**	**6,367**	**6,598**	**6,867**	**269**	**4.1**
ETH Zurich	3,795	3,889	3,975	4,026	4,010	4,092	4,175	4,168	4,316	4,460	144	3.3
EPFL	2,041	2,058	2,032	2,077	2,124	2,142	2,216	2,199	2,282	2,407	125	5.5
Total students and doctoral students[1]	**27,087**	**28,046**	**28,537**	**29,357**	**30,351**	**31,293**	**32,531**	**33,642**	**35,235**	**36,110**	**–**	**–**
ETH Zurich	17,781	18,178	18,616	19,233	19,815	20,607	21,397	22,193	23,422	23,983	–	–
EPFL	9,306	9,868	9,921	10,124	10,536	10,686	11,134	11,449	11,813	12,127	–	–

[1] Until 2016, visiting students (incoming) were counted yearly in the numbers of students at Bachelor's and Master's levels. In 2017–2020, visiting students were reported yearly as a separate student category and counted in the total number of students. Since 2021, visiting students are reported per semester in a separate table (see Fig. 11, p. 96) and are no longer counted in the total number of students. Without this modification, ETH Zurich and EPFL would have counted a total of 30,294 in 2021.

Fig. 6: New admissions to the Bachelor's level at ETH Zurich and EPFL

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Δ 2020 / 2021	
												in %
Architecture	599	604	564	573	569	437	450	468	498	550	52	10.4
Civil and Geomatic Engineering	620	613	486	493	488	366	370	383	403	384	−19	−4.7
Engineering Sciences	1,354	1,429	1,393	1,550	1,518	1,350	1,303	1,353	1,327	1,333	6	0.5
Information and Communications Technology	465	547	595	596	679	582	662	708	780	799	19	2.4
Exact and Natural Sciences	986	969	952	1,001	1,108	985	928	952	1,074	1,091	17	1.6
Human Medicine[1]	–	–	–	–	–	100	100	100	100	99	−1	−1.0
Life Sciences	700	744	721	695	778	635	696	725	719	659	−60	−8.3
System-oriented Natural Sciences	336	335	316	366	372	288	307	259	326	288	−38	−11.7
Management, Technology, Economics	–	–	–	–	–	–	–	–	–	–	–	–
Humanities, Social and Political Sciences	12	14	14	16	19	13	11	18	18	15	−3	−16.7
Total	**5,072**	**5,255**	**5,041**	**5,290**	**5,531**	**4,756**	**4,827**	**4,966**	**5,245**	**5,218**	**−27**	**−0.5**

[1] ETH Zurich introduced a Bachelor's degree in Human Medicine in 2017. New admissions in this discipline are limited to 100 and will therefore remain stable over the years.

Fig. 7: Percentage of women among students and doctoral students at ETH Zurich and EPFL

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
% at the Bachelor's level	29.2	28.6	28.7	29.2	30.0	30.6	31.6	31.9	32.0	32.5
% at the Master's level	28.7	29.4	29.5	28.6	28.5	29.4	29.6	29.8	30.3	30.4
% at the Bachelor's and Master's level	29.0	28.9	29.0	28.9	29.4	30.1	30.8	31.1	31.3	31.6
% on MAS/MBA programmes	36.7	34.6	35.0	38.6	37.9	38.8	40.6	40.3	42.6	42.1
% at the doctoral level	29.8	30.4	30.6	30.6	31.0	30.8	31.4	32.8	33.6	33.9

Fig. 8: Supervision ratios at ETH Zurich and EPFL

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Supervision ratio										
at Bachelor's/Master's level	27.3	27.7	28.0	28.6	29.2	28.3	29.7	30.6	31.7	33.2
at doctoral level	7.8	7.7	7.8	7.8	7.7	7.6	7.8	7.7	7.7	8.0
Extended supervision ratio										
at Bachelor's/Master's level	18.4	18.7	18.8	19.3	19.8	19.2	20.0	20.7	21.5	22.5
at doctoral level	5.3	5.2	5.2	5.3	5.2	5.1	5.3	5.2	5.2	5.4

Fig. 9: Percentage of foreign nationals among students and doctoral students at ETH Zurich and EPFL

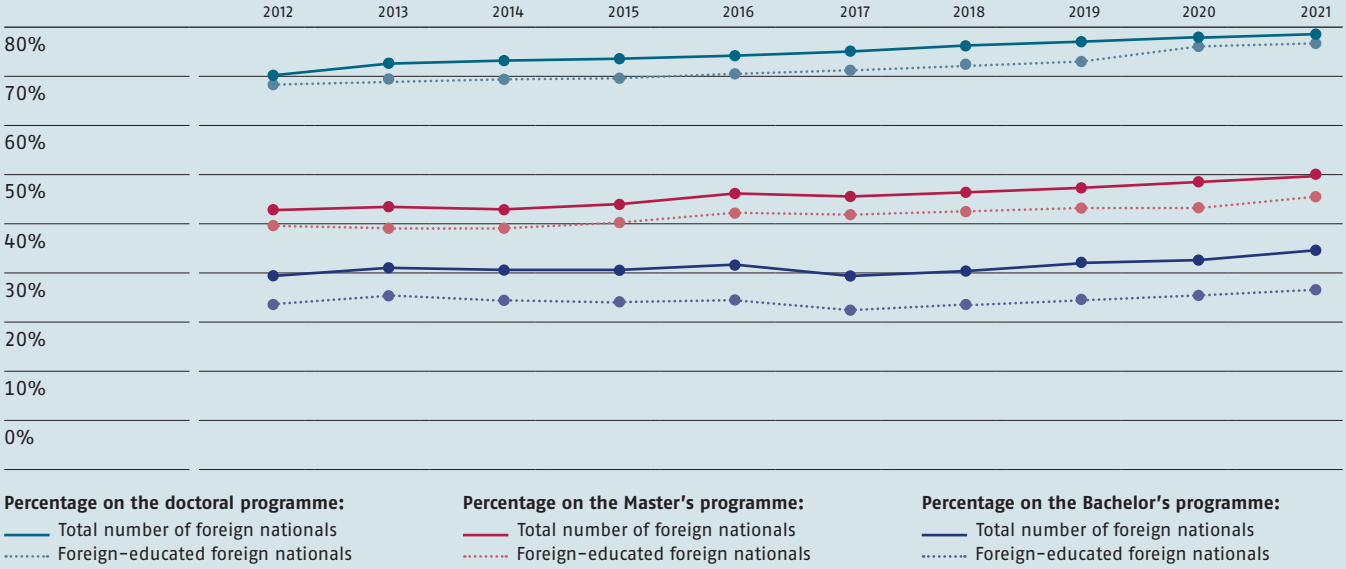


Fig. 10: Degrees awarded by academic level

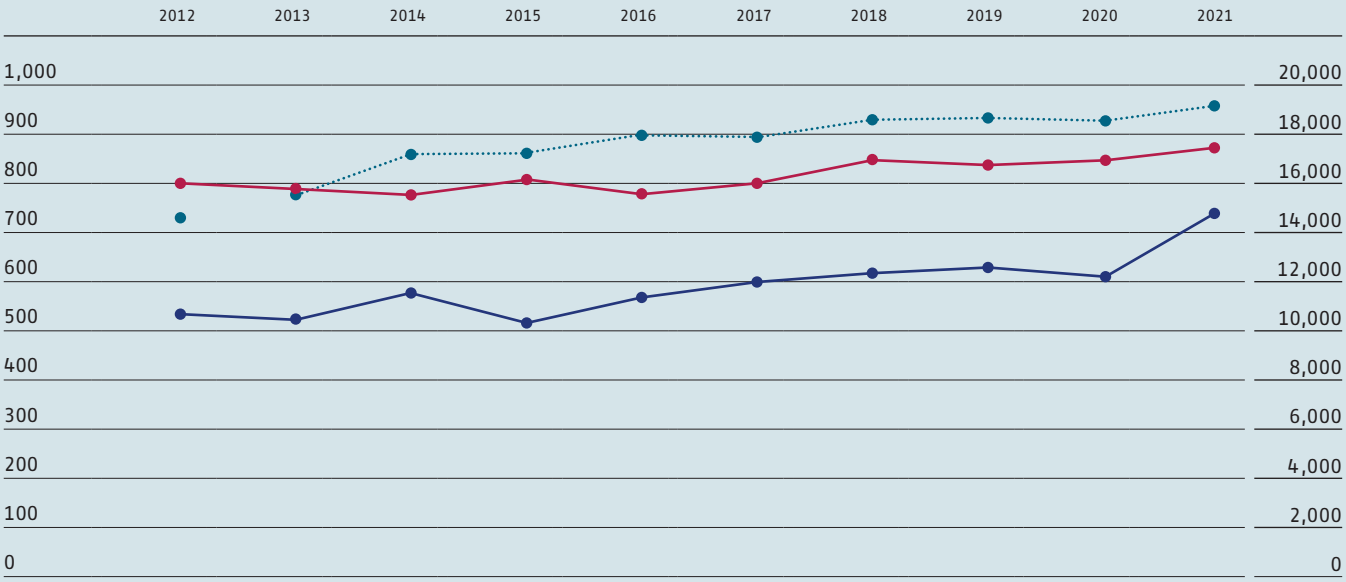
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Δ 2020 / 2021	
												in %
Bachelor	**2,216**	**2,249**	**2,538**	**2,528**	**2,500**	**2,602**	**2,686**	**2,876**	**3,007**	**3,213**	**206**	**6.9**
ETH Zurich	1,447	1,447	1,579	1,564	1,571	1,606	1,678	1,758	1,843	2,084	241	13.1
EPFL	769	802	959	964	929	996	1,008	1,118	1,164	1,129	−35	−3.0
Master	**2,320**	**2,663**	**2,711**	**2,821**	**2,989**	**3,065**	**3,240**	**3,368**	**3,344**	**3,898**	**554**	**16.6**
ETH Zurich	1,650	1,847	1,839	1,879	2,015	2,072	2,196	2,335	2,260	2,723	463	20.5
EPFL	670	816	872	942	974	993	1,044	1,033	1,084	1,175	91	8.4
MAS / MBA	**256**	**346**	**260**	**254**	**303**	**394**	**343**	**324**	**249**	**304**	**55**	**22.1**
ETH Zurich	184	228	205	175	203	272	232	245	160	219	59	36.9
EPFL	72	118	55	79	100	122	111	79	89	85	−4	−4.5
Doctorate	**1,095**	**993**	**1,197**	**1,109**	**1,256**	**1,258**	**1,209**	**1,290**	**1,171**	**1,257**	**86**	**7.3**
ETH Zurich	747	579	769	718	851	827	802	866	781	820	39	5.0
EPFL	348	414	428	391	405	431	407	424	390	437	47	12.1

Fig. 11: Visiting students

	2021	
	Spring Semester	Autumn Semester
Incoming		
at ETH Zurich	287	460
at EPFL	552	622
Outgoing		
from ETH Zurich	76	154
from at EPFL	264	396

Since 2021, visiting students are no longer being counted in the student totals and now figure only in the table above per semester. It should be noted that the figures given per semester cannot be added together to obtain an annual total without counting students present during the two semesters twice.

Fig. 12: Teaching and supervision by research institutes



Left axis: Number of supervised Bachelor's, Master's, Diploma and doctoral theses
Right axis: Number of teaching hours per year

Number of supervised doctoral theses
Number of supervised Bachelor's, Master's and Diploma theses
Number of teaching hours per year

Knowledge and technology transfer

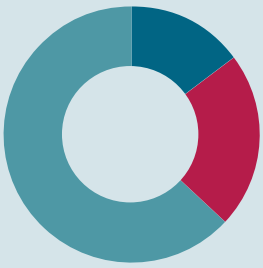
Fig. 13: Knowledge and technology transfer in the ETH Domain

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Invention disclosures[1]	**–**	**–**	**–**	**–**	**–**	**343**	**358**	**329**	**310**	**330**
ETH Zurich	–	–	–	–	–	171	205	159	165	169
EPFL	–	–	–	–	–	134	119	132	107	121
Research institutes	–	–	–	–	–	38	34	38	38	40
Software notifications[1,2]	**–**	**–**	**–**	**–**	**–**	**26**	**36**	**40**	**32**	**39**
ETH Zurich	–	–	–	–	–	20	19	26	18	24
EPFL	–	–	–	–	–	6	13	13	14	12
Research institutes	–	–	–	–	–	0	4	1	0	3
Patents	**195**	**193**	**211**	**219**	**230**	**206**	**230**	**224**	**217**	**213**
ETH Zurich	87	103	82	98	109	84	109	102	115	99
EPFL	75	66	99	88	100	95	95	98	75	88
Research institutes	33	24	30	33	21	27	26	24	27	26
Licences[3]	**230**	**223**	**270**	**311**	**353**	**377**	**341**	**324**	**338**	**181**
ETH Zurich	35	38	35	50	78	82	87	62	43	27
EPFL	31	41	46	48	58	50	39	50	53	40
Research institutes	164	144	189	213	217	245	215	212	242	114
Spin-off	**38**	**43**	**49**	**48**	**50**	**48**	**55**	**59**	**66**	**60**
ETH Zurich	22	24	22	25	25	25	27	30	34	25
EPFL	12	12	24	18	20	15	25	23	25	32
Research institutes	4	7	3	5	5	8	3	6	7	3

1 Invention disclosures and software notifications were introduced in 2017 as additional KTT indicators.
2 Open Source Software not included
3 The definition of licences was revised in 2021. This category no longer includes contracts with prior IP transfer and contracts for software licences of less than CHF 1,000. This should be taken into account when comparing with the figures for previous years. Without this change, the total number of licences would have been 410 in 2021.

Licences

181



ETH Zurich	27
EPFL	40
Research institutes	114

Invention disclosures

330

Software notifications

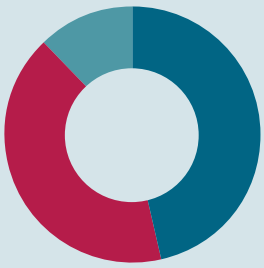
39

Spin-offs

60

Patents

213



ETH Zurich	99
EPFL	88
Research institutes	26

Fig. 14: Cooperation with the private and public sector

	2017	2018	2019	2020	2021
Collaboration contracts with the private sector	**507**	**594**	**570**	**610**	**585**
of which financed by the private sector	**316**	**415**	**404**	**388**	**396**
ETH Zurich	122	149	163	143	172
EPFL	99	120	125	95	94
Research institutions	95	146	116	150	130
of which financed by Innosuisse/EU-FP *	**191**	**179**	**166**	**222**	**189**
ETH Zurich	57	74	55	72	72
EPFL	66	49	61	56	45
Research institutions	68	56	50	94	72
Collaboration contracts with the Swiss public sector	**285**	**261**	**278**	**262**	**272**
ETH Zurich	88	100	88	92	94
EPFL	54	43	51	47	46
Research institutions	143	118	139	123	132

Number of new cooperation agreements (research agreements and scientific services) with the private and Swiss public sector involving a volume of at least CHF 50,000 per contract. These indicators were introduced in 2017.
* EU-FP: European Framework Programmes for Research and Innovation

KTT indicators and counting method

Patents exclusively refer to first filings. The definition of licences was revised in 2021. This category now no longer includes contracts involving previous IP transfer or software licence contracts with a value of less than CHF 1,000. This must be taken into account when comparing these figures with those from previous years. The invention disclosures and software notifications correspond to the reports and notifications submitted in writing to the Technology Transfer Offices of the institutions of the ETH Domain in the reporting period. They reflect activities in the early phases of the innovation process, thereby supplementing the other KTT indicators. Open source software is not considered.

In order to reflect the cooperation between the institutions and private enterprise and the public sector, only recently concluded cooperation agreements are included. These are only research contracts and scientific services with a volume of at least CHF 50,000 per contract. Cooperation with the private sector is divided into two categories: projects that are directly financed by industry in Switzerland or abroad; and those funded by Innosuisse or the EU Research Framework Programmes for Research and Innovation (EU FP). Cooperation with the public sector includes contracts with public sector institutions in Switzerland but not those with national or international research funding organisations and foundations.

Rankings observed worldwide (see Fig. 15 und 16)

The universities are assessed and ranked by institutions and businesses using various methods. THE (Times Higher Education World University Rankings) uses 13 key performance indicators for teaching (30% weighting), research (30%), citations (30%), international outlook (7.5%) and industry income (2.5%).

QS (QS World University Rankings) focuses mainly on reputation (with a 40% weighting on academic reputation and 10% on employer reputation, followed by faculty/student ratio (20%), citations per faculty (20%) and international faculty ratio/international student ratio (5% each).

ARWU (Academic Ranking of World Universities of Shanghai Ranking Consultancy) makes use of performance indicators based on the academic performance or research output – in particular Nobel Prizes or Fields Medals – of graduates, staff and highly cited researchers from the institutions assessed. The publication activity of an institution is also judged based on the number of articles that have been published in a select group of the most respected journals, and the ratio between the number of publications and the number of researchers employed at an institution.

CWTS Leiden (Centre for Science and Technology Studies Leiden Ranking) is based solely on the publication activity of the universities, using this to calculate the indicators to assess research performance. One commonly used indicator for ranking the universities in the CWTS Leiden ranking is the number and proportion of publications each university has among the top 10% of the most-cited publications in the relevant field (PP (top 10%)). The CWTS Leiden World and Europe rankings of both Federal Institutes of Technology (see Fig. 15) are based on this indicator.

University rankings

Fig. 15: Rankings of ETH Zurich (blue) and EPFL (red) according to the THE, QS, ARWU and CWTS Leiden Rankings in 2021/2022

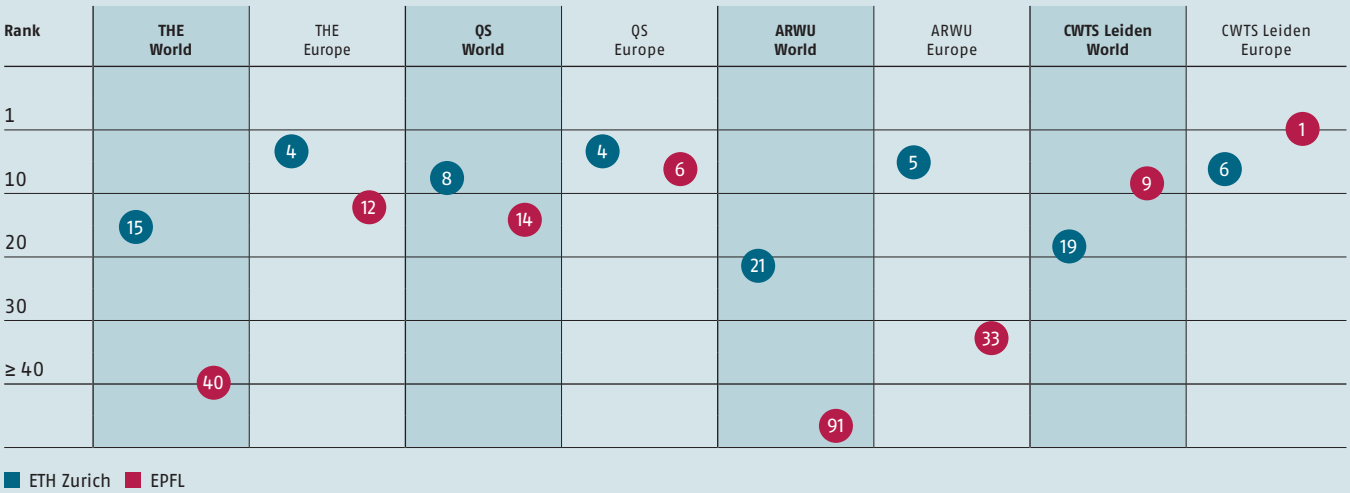
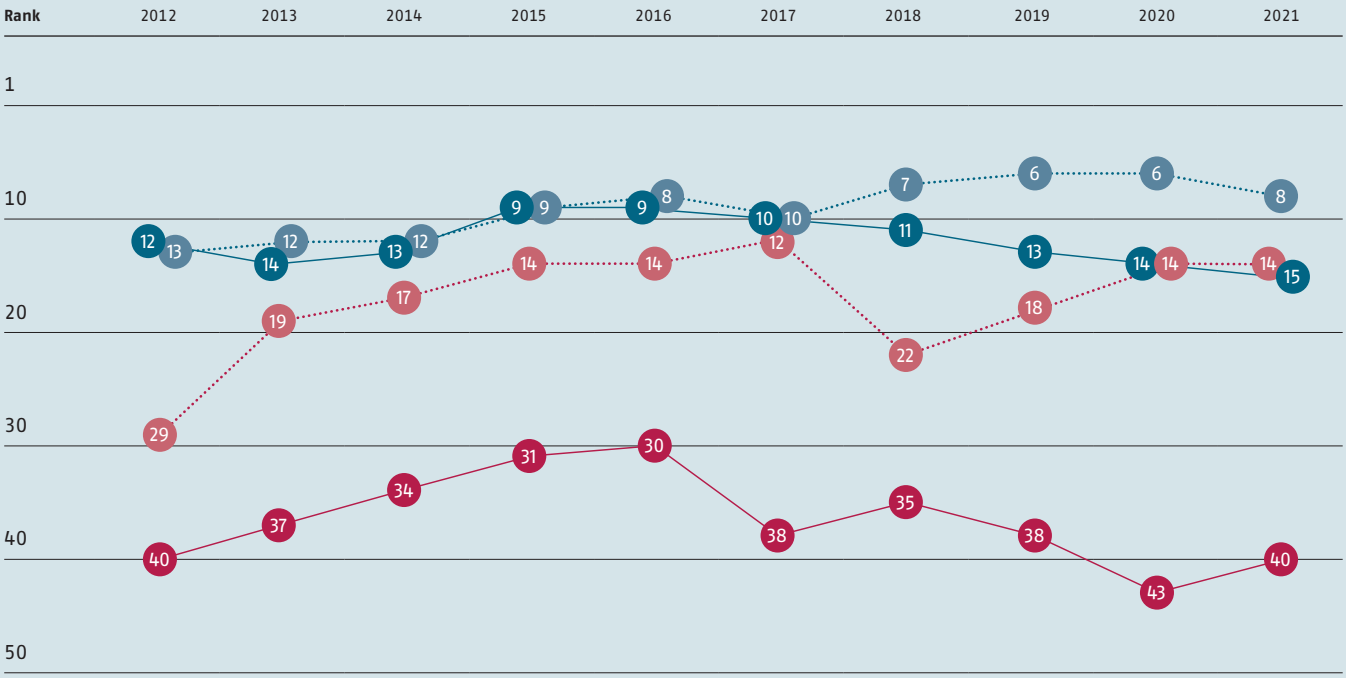


Fig. 16: Rankings of ETH Zurich (blue) and EPFL (red) according to the THE and QS World Rankings 2012–2021



THE	**Times Higher Education World University Rankings** from TES Global Limited, London
QS	**QS World University Rankings** from Quacquarelli Symonds Limited, London
ARWU	**Academic Ranking of World Universities** from ShanghaiRanking Consultancy
CWTS Leiden	**CWTS Leiden Ranking** from the Centre for Science and Technology Studies (CWTS) of the University of Leiden, Netherlands; Indicator used PP (top 10%) (see box on the left)

Personnel

Fig. 17: Headcount and employment level by function group

	Men			Women			ETH Domain		
2021	EC	FTE	ø EL %	EC	FTE	ø EL %	EC	FT	ø EL %
Professors (F/A)	595	568.4	95.5	115	110.8	96.3	710	679.2	95.7
Assistant professors with tenure track	86	86.0	100.0	44	44.0	100.0	130	130.0	100.0
Assistant professors without tenure track	30	29.2	97.3	17	16.2	95.3	47	45.4	96.6
Scientific personnel	9,994	8,435.9	84.4	4,795	3,841.5	80.1	14,789	12,277.4	83.0
of whom senior scientific personnel	690	661.8	95.9	115	105.4	91.7	805	767.2	95.3
Technical personnel	3,168	2,983.1	94.2	934	739.2	79.1	4,102	3,722.3	90.7
Administrative personnel	1,359	1,181.2	86.9	2,666	2,033.7	76.3	4,025	3,214.9	79.9
Apprentices	321	321.0	100.0	144	143.6	99.7	465	464.6	99.9
Total	**15,553**	**13,604.8**	**87.5**	**8,715**	**6,929.0**	**79.5**	**24,268**	**20,533.8**	**84.6**

Headcount (employment contracts, EC) and employment level (EL) of men, women and the entire ETH Domain by function group. Senior scientists, maîtres d'enseignement et de recherche (MER) and other senior personnel are counted separately, but nevertheless are still included under scientific personnel. A total of 6,867 doctoral students are enrolled at the two Federal Institutes of Technology. Of these, all who are employed in the ETH Domain are included under scientific personnel.

Fig. 18: Development in the numbers of female and male professors

	2021			2020			Changes		
2021	Men	Women	Total	Men	Women	Total	Men in %	Women in %	Total in %
Professors (F/A)	595	115	710	594	107	701	0.2	7.5	1.3
Assistant professors with tenure track	86	44	130	93	41	134	−7.5	7.3	−3.0
Assistant professors without tenure track	30	17	47	36	16	52	−16.7	6.3	−9.6
Total professors	**711**	**176**	**887**	**723**	**164**	**887**	**−1.7**	**7.3**	**0.0**

Change in the number of professors according to: full and associate professors, assistant professors with tenure track and assistant professors without tenure track. The three last columns show the percentage change since the previous year.

Professorial categories

The various professorial categories differ with regard to status and employment conditions. Full (F) and associate (A) professors, and assistant professors with and without tenure track (TT) teach and undertake research at both Federal Institutes of Technology. Professors with TT can become permanently employed as full or associate professors if they meet a certain performance target. Full and associate professors are appointed permanently, while assistant professors sign employment contracts for four years. The latter can be renewed for a maximum of another four years; in the case of parenthood or for any other just cause, it is possible to renew the employment contacts for up to another year.

In the context of cooperating with other universities and research institutions, there is the option of a dual professorship and the appointment of affiliated professors with a low FTE level.

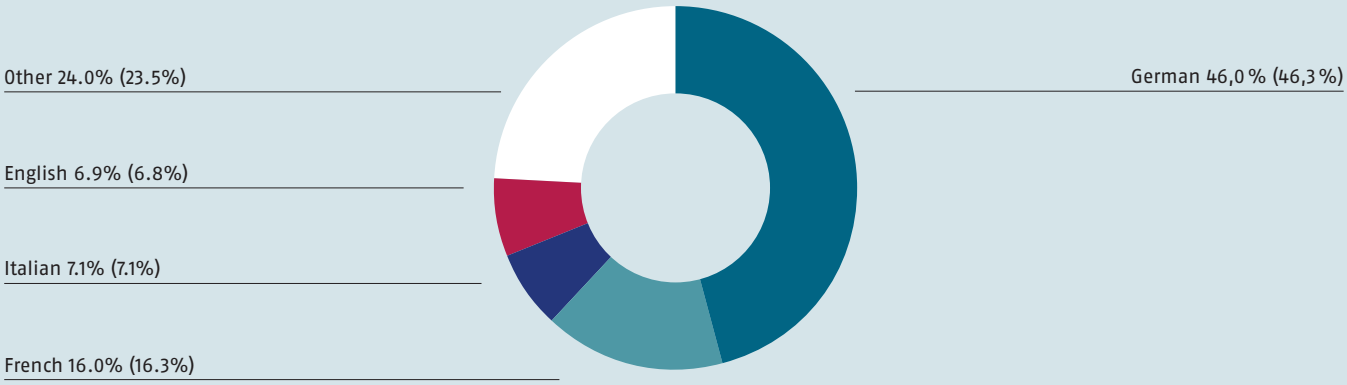
A purely honorary title, on the other hand, is the appointment as adjunct professor for especially well-deserved privatdozents, Maître d'enseignement et de recherche (MER) and lecturers. The ordinance concerning professors does not apply to these persons.

Fig. 19: Origin of male and female professors

	Switzerland			EU			Other		
2021	Men	Women	Total	Men	Women	Total	Men	Women	Total
Professors (F/A)	230	37	267	279	58	337	86	20	106
Assistant professors with tenure track	9	4	13	45	21	66	32	19	51
Assistant professors without tenure track	10	3	13	9	12	21	11	2	13
Total professors	**249**	**44**	**293**	**333**	**91**	**424**	**129**	**41**	**170**

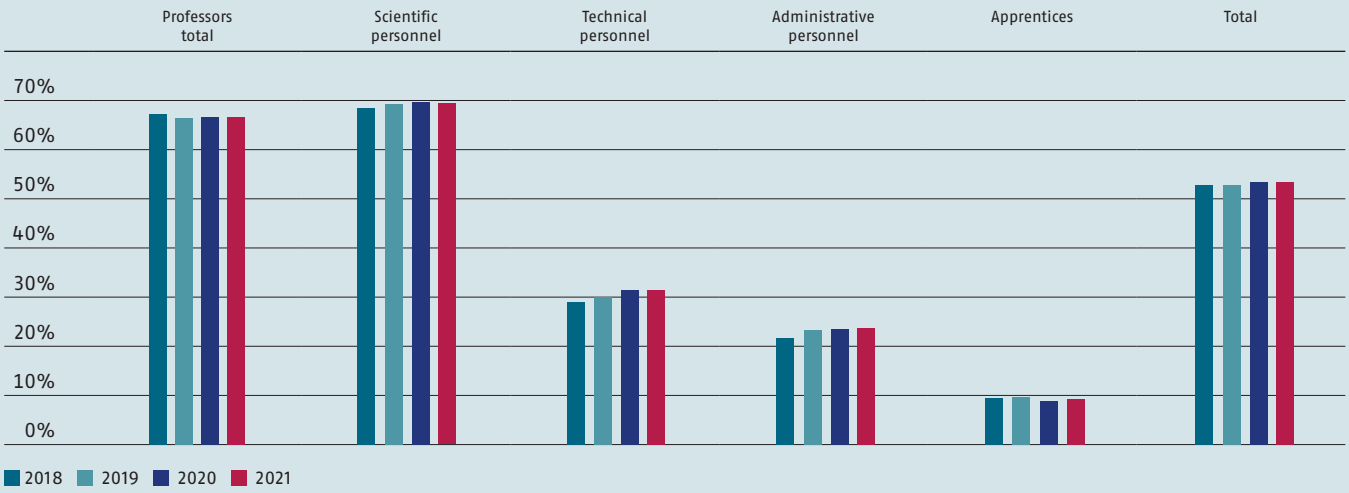
Number of professors broken down by origin: Switzerland, the EU and other countries.

Fig. 20: Employees' native languages



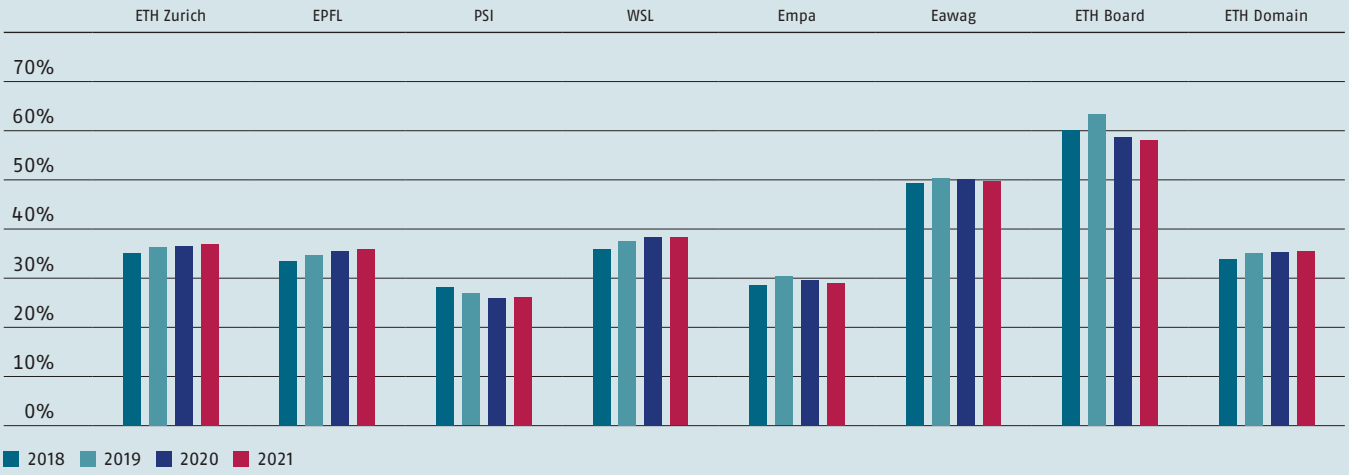
Native languages of employees in the ETH Domain in 2021. Figures for the previous years are shown in brackets.

Fig. 21: Development in the proportions of foreign employees by function group



Development in the proportions of foreign employees in the ETH Domain by function group (in relation to the number of employment contracts)

Fig. 22 Development in the proportion of women by institution



Development in the proportion of women by institution over the past four years (in relation to the number of employment contracts)

Fig. 23: Source of funds by function group

Function group		Professors (all)	Scientific personnel	Technical personnel	Administrative personnel	Total FTE
Source of funds						
Total federal contribution Federal financial contribution	2020	784.6	6,041.1	3,004.7	2,776.3	12,606.7
	2021	778.0	6,086.9	3,045.9	2,853.3	12,764.1
	Δ 2020 / 2021	−6.6	45.8	41.2	77.0	157.4
Third-party resources Research funding (SNSF, Innosuisse, other), government-funded research and EU research programmes (EU-FP)	2020	35.6	4,360.5	273.8	106.3	4,776.2
	2021	31.0	4,350.1	262.8	81.3	4,725.2
	Δ 2020 / 2021	−4.6	−10.4	−11.0	−25.0	−51.0
Industry-oriented research, donations/bequests	2020	34.4	1,593.3	397.5	236.3	2,261.5
	2021	45.6	1,835.6	413.6	285.1	2,579.9
	Δ 2020 / 2021	11.2	242.3	16.1	48.8	318.4
Total	2020	854.6	11,994.9	3,676.0	3,118.9	19,644.4
	2021	854.6	12,272.6	3,722.3	3,219.7	20,069.2
	Δ 2020 / 2021	0.0	277.7	46.3	100.8	424.8

Source of funds according to function groups (in FTEs) in 2021 compared to 2020. Δ (delta) shows the absolute change compared to the previous year. Figures exclude apprentices (464.6 FTEs) and trainees.

Real estate

Fig. 24: Source of funds for ETH Domain constructions (in CHF millions)

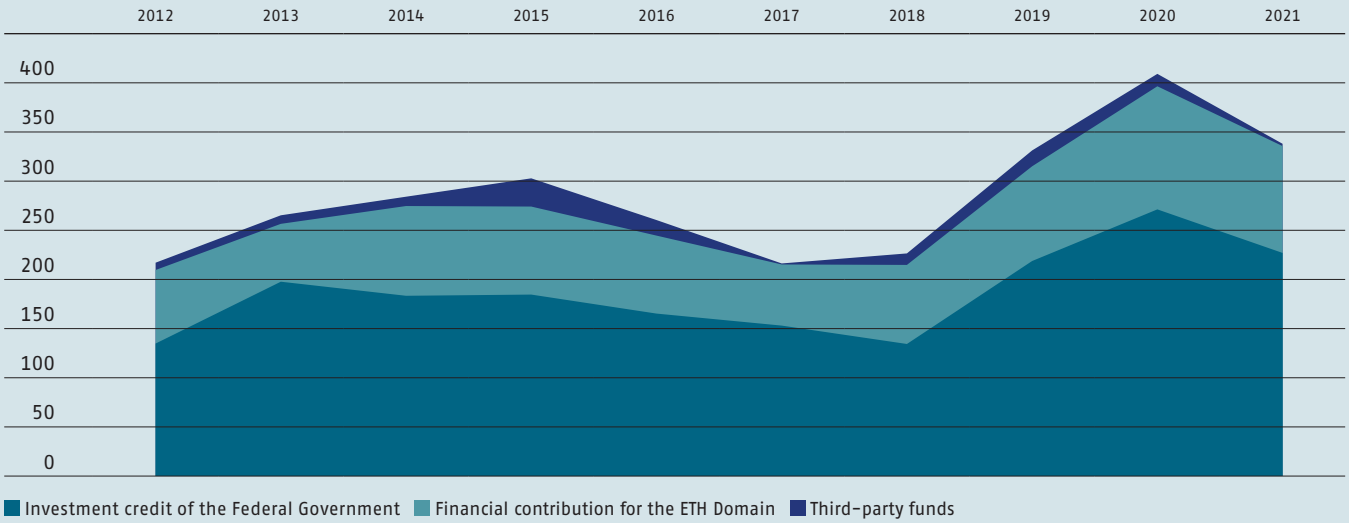
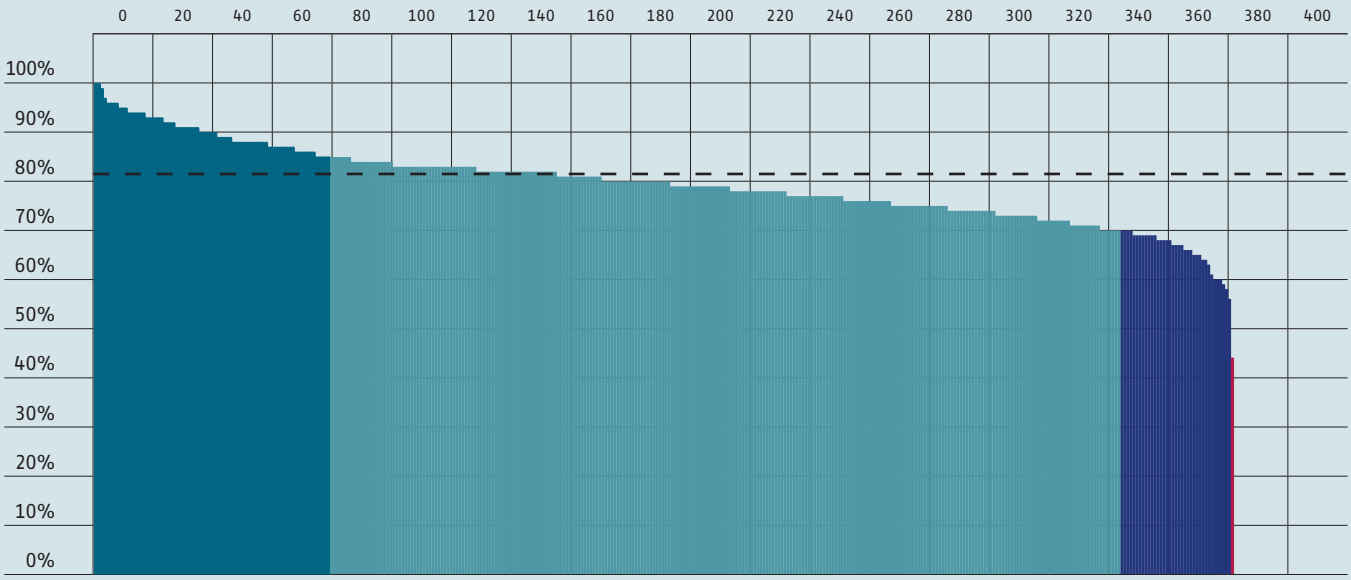


Fig. 25: Condition value as of 31 December 2021



Number of properties recorded: 382

- Very good condition, as new
- Good condition, no measures needed
- Average condition, plan and implement measures
- Poor condition, measures needed
- Average weighted by original value of properties: 82%

Fig. 26: Development of the main usable area by institution in %

Fig. 27: Mix of areas (in 1,000 m²)

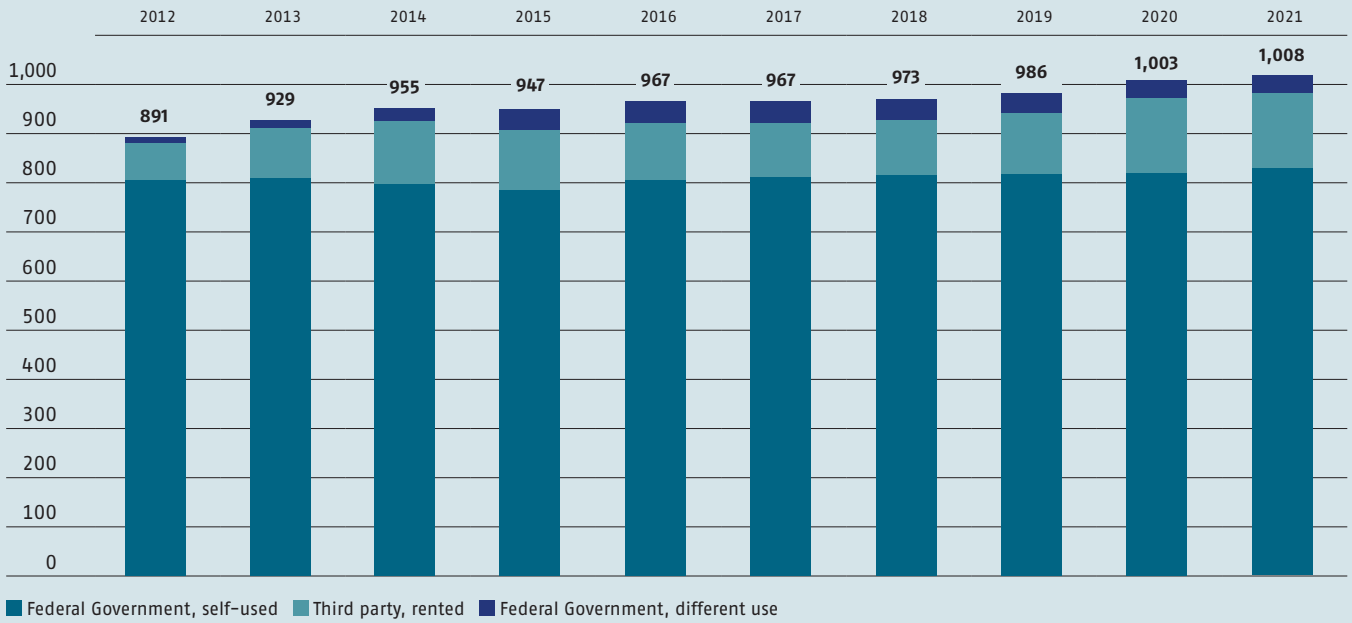


Fig. 28: Quantity structure of the ETH Domain portfolio

CHF millions	ETH Zurich	EPFL	PSI	WSL	Empa	Eawag	Total
Buildings/facilities							
Quantity	162	86	133	23	27	14	445
Original value	3,653	1,714	639	103	368	127	6,603
Book value	1,234	839	212	41	82	67	2,475
Plots							
Quantity	67	20	14	15	4	4	124
Book value	693	243	30	24	63	10	1,064
Book value of installations under construction	478	63	17	6	22	2	589
Building rights (not valuated, in compliance with regulations)							0
Total assets (book value real estate)	**2,405**	**1,145**	**259**	**70**	**168**	**80**	**4,128**
Provisions (e.g. for polluted sites, asbestos, radioactive waste)							262

Quantity and value of all government-owned real estate allocated to the institutions of the ETH Domain.

Fig. 29: Investments

CHF 1,000	ETH Zurich	EPFL	PSI	WSL	Empa	Eawag	Total
Investment credit from Federal Government	140,300	39,000	22,560	4,370	18,500	2,020	226,750
of which for new or replacement constructions	60,349	11,873	17,027	4,111	14,507	1,133	109,000
of which for maintenance of value and functionality	79,951	27,127	5,533	259	3,993	887	117,750
Financial contribution investments (for user-specific construction)	80,825	12,241	4,983	943	6,281	3,351	108,625
Third-party resources	1,009	0	0	0	1,323	0	2,332
Construction expenses of the Institutions	222,134	51,241	27,543	5,313	26,103	5,371	337,707
Main usable area (m^2)	509,480	290,670	110,750	18,230	58,880	19,920	1,007,930
Construction expenses per m^2 main usable area (CHF/m^2)	436	176	249	291	443	270	335

2021 investments in the ETH Domain portfolio, based on the main usable area (in m^2). This is the part of the usable area that is directly allocated to the core task of teaching and research. Because the research institutes themselves do not provide teaching, a figure for the area across the entire Domain – for example in relation to the number of students – would not be very informative.

Environment and energy

Fig. 30: Environment and energy data

		ETH Domain 2019	ETH Domain 2019	ETH Zurich Total	EPFL Total	PSI Total	WSL Total	Empa Total	Eawag Total	ETH Domain Trend 2021[1]
BASIC DATA										
Energy reference area (ERA)[2]	m^2	1,461,445	1,467,944	693,711	426,168	170,599	25,924	123,442	28,100	1,479,455
Full-time equivalent[3]	FTE	38,453	39,941	22,908	12,406	2,030	786	1,131	680	41,763
ENERGY[4]										
Final energy, net[7]	**kWh / a**	**433,298,723**	**439,003,317**	**188,732,905**	**104,399,000**	**123,004,500**	**4,347,907**	**14,727,205**	**3,791,800**	**487,789,599**
Electricity, net (not incl. self-produced)	**kWh / a**	**338,918,497**	**321,431,871**	**124,991,756**	**63,988,000**	**115,993,500**	**2,951,496**	**10,267,234**	**3,239,885**	**361,210,773**
Consumption of uncertified electricity	kWh / a	40,823,700	0	0	0	0	0	0	0	
Consumption of certified electricity	kWh / a	298,094,797	321,431,871	124,991,756	63,988,000	115,993,500	2,951,496	10,267,234	3,239,885	
Electricity (without naturemade star)	kWh / a	289,168,394	312,189,265	120,991,756	61,643,000	115,993,500	800,791	12,760,218	0	
Photovoltaic naturemade star	kWh / a	2,085,076	2,080,997	0	2,000,000	0	0	0	80,997	
Hydro power naturemade star	kWh / a	13,902,965	13,599,888	4,000,000	4,441,000	0	2,000,000	0	3,158,888	
Wind naturemade star	kWh / a	181,550	150,705	0	0	0	150,705	0	0	
Sale of electricity	kWh / a	−7,243,188	−6,588,984	0	−4,096,000	0	0	−2,492,984	0	
Heat	**kWh / a**	**93,583,133**	**116,069,503**	**63,015,000**	**40,411,000**	**6,853,000**	**918,238**	**4,320,350**	**551,915**	
Fuel oil	kWh / a	6,468,680	791,168	16,000	258,000	456,000	60,219	0	949	
Natural gas	kWh / a	61,567,793	80,275,186	36,672,000	39,434,000	0	0	4,164,329	4,857	
District heating	kWh / a	51,263,195	59,197,109	50,872,000	719,000	6,397,000	0	663,000	546,109	
Woodchip	kWh / a	1,099,290	858,019	0	0	0	858,019	0	0	
Sale of heat	kWh / a	−26,815,825	−25,051,979	−24,545,000	0	0	0	−506,979	0	
Fuels (own vehicles)	**kWh / a**	**1,598,376**	**1,501,943**	**726,149**	**0**	**158,000**	**478,173**	**139,621**	**0**	
Energy: additional information										
Energy costs, electricity and heat[5]	CHF / a	51,282,272	48,998,517	24,532,022	10,417,682	11,327,549	434,838	1,808,441	477,985	55,972,881
Self-generated renewable electricity	kWh / a	2,820,765	914,989	238,371	0	14,566	130,410	363,293	168,349	
Total sale to third parties	kWh / a	−34,059,013	−31,133,984	−24,545,000	−4,096,000	0	0	−2,492,984	0	
WATER (DRINKING WATER)	M^3	696,654	480,661	262,275	134,025	55,394	6,991	16,756	5,220	369,734
MATERIALS										
Paper	**kg**	**234,464**	**184,528**	**93,500**	**59,982**	**19,862**	**4,757**	**3,835**	**2,592**	**133,889**
Paper, new fibre	kg	70,921	50,119	16,500	23,895	9,084	502	125	13	32,152
Paper, recycled	kg	163,543	134,409	77,000	36,087	10,778	4,255	3,710	2,579	101,737
KEY FIGURES: ENVIRONMENTAL IMPACT										
Primary energy[6]	**kWh / a**	**578,932,282**	**510,064,300**	**207,666,127**	**125,736,020**	**147,455,000**	**6,664,535**	**17,695,628**	**4,846,991**	
Proportion of renewable energies	**%**	**66**	**66**	**57**	**51**	**93**	**58**	**69**	**80**	
CO_2 emissions	**t CO_2 / a**	**37,279**	**32,704**	**17,736**	**12,172**	**524**	**347**	**1,678**	**247**	

1 Provisional figures for the year under review (trend), as at: start of March 2022.
2 The energy reference area is the sum of all gross floor areas, above and below ground, which must be heated or air-conditioned in order to be used.
3 The FTE (full-time equivalent) value listed here was supplemented by the number of students with an FTE value of 0.68 to produce the consumption per person.
4 The key figures indicated for electricity and heat show the total consumption of both for buildings, as well as for teaching and research activities.
5 The key indicator "energy costs" shows all expenditure (cash out) for the provision of energy (heat and electricity).
6 In energy economics, one refers to primary energy as the energy that is available using the original forms or resources of energy, such as fuel (e. g. coal or natural gas), as well as energy carriers such as sun, wind or nuclear fuels.
7 Final energy is the portion of the primary energy that is left after losses due to energy conversion and transmission, after it is supplied via the consumer's domestic connection. The final energy basically corresponds to the energy that is purchased.

FINANCES

* Extract of the Financial Report 2021

Financial Report:
www.ethboard.ch/financialreport2021

Financial overview

In 2021, it was possible to carry out research activities almost like before the pandemic and further significant investments were made. Both of these resulted in high expenses and a reduction in liquidity assets. In the form of the total federal contribution, the Federal Government provides the ETH Domain with solid basic funding for its teaching and research activities as well as the corresponding investments required.

Financial overview of the ETH Domain
In the financial overview of the ETH Doman, receipts and expenditure are shown and allocated to the period in which the funds flow.

The situation is different with the consolidated financial statements of the ETH Domain, which are based on the concept of consumption of resources: the revenue and expenses are accrued to the period to which they belong. It can be found in the separate financial report (www.ethboard.ch/financialreport2021). Further information can be found at the end of this chapter on pages 112 and 113 in an excerpt from the financial statements (balance sheet, statement of financial performance).

In the financial overview, to have a comprehensive view of the cash flows as well as the credits from the total federal contribution which are credited against the expenditure ceiling, the income from third-party funding is added to the total and offset against the expenditure for operations and investments.

On the one hand, the total federal contribution covers the basic equipment for teaching and research, and on the other hand it is used to finance real estate used by the ETH Domain that is largely owned by the Federal Government. The Federal Government has transferred the management of the state-owned real estate used to the ETH Domain. Investments triggered and monitored by the ETH Domain in this real estate are explained in the Annual Report, from page 79 onwards. Only by including the investment credit (inflow of funds) that is located at the Federal Office for Buildings and Logistics (FOBL) (credit A202.0134) and investments in state-owned real estate is it possible to provide a financial overview of the funds received by the ETH Domain and their appropriation. The financial overview therefore reflects the political control exercised by the Federal Government, irrespective of the ownership status of the real estate.

In contrast, in the consolidated financial statements of the ETH Domain (see Financial Report www.ethboard.ch/financialreport2021), not the investment credit but the federal contribution to accommodation (A231.0182: Federal contribution to accommodation of the ETH Domain), which corresponds to a credit for the use of this real estate owned by the Federal Government, is taken into account.

Figure 31 shows the financial overview for the ETH Domain for 2021. The source and allocation of funds in the reporting period 2021 are explained in the following paragraphs.

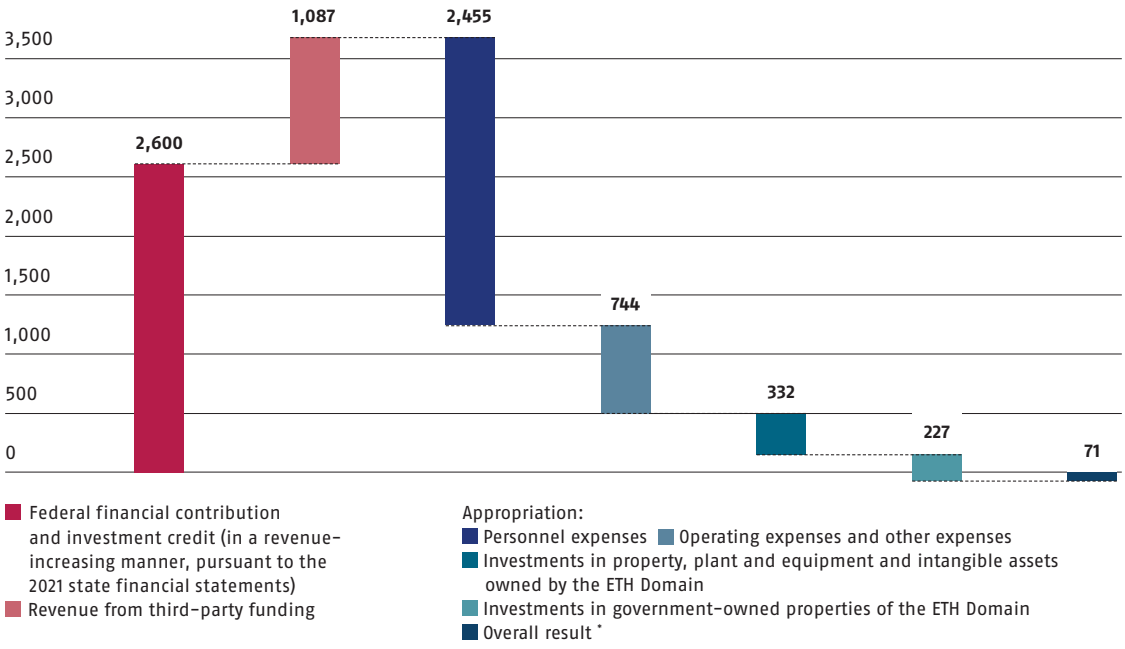
* Further information on the expenditure ceiling and credits can be found at the end of this chapter.

Source of funds (income) in 2021
In 2021, the ETH Domain received credits amounting to CHF 2,600m. The federal financial contribution (credit A231.0181) amounted to CHF 2,373m and the investment credit was CHF 227m. Since unlike in the previous year, no dedicated reserves were either generated or released where the investment credit was concerned, the ETH Domain received a total of CHF 2,600m from the total federal contribution (2020: CHF 2,626m).

The consolidated revenue from third-party funding amounted to CHF 1,087m (2020: CHF 1,093m). It came from project-oriented research contributions, donations, tuition fees and other income. Consequently, the total income of the ETH Domain in 2021 amounted to CHF 3,687m (previous year CHF 3,719m).

Allocation of funds (expenses) in 2021
The funds are used on the one hand for personnel expenses in teaching, research and administration, and on the other for operating expenses and investments in immovable property, plant and equipment, and movable and intangible non-current assets. The total expenses in 2021 amounted to CHF 3,758m. The previous year's reference value (CHF 3,653m) was exceeded by CHF 105m. Personnel account for the main share of the funds, whose share of the total expenses remained at last year's level of 65%. Investments were slightly down and account for 15% of total expenses (2020: 20%). The amount of operating expenses and other expenses (2021: 20%, 2020: 19%) for infrastructure and projects in teaching and research depends on numerous factors (cf. Financial Report www.ethboard.ch/financialreport2021). After having decreased due to the pandemic in 2020, in 2021 they rose again and contributed, together with the personnel expenses (which were also higher), to the increase in expenses.

Fig. 31: Income (CHF 3,687m) and the appropriation thereof
CHF millions



* The overall result (consolidated CHF 71m) was CHF 39m below the consolidated surplus according to IPSAS (CHF 110m), due to the effects of various accounting principles (essentially: accruement of income to the period to which it belongs, net pension obligations and the result of the associated entities)

Personnel expenses
The total of CHF 2,455m was CHF 65m higher than the reference value for 2020 (CHF 2,390m). In 2021, 20,069 full-time equivalents (FTEs; reporting date values) were financed, spread over 23,803 employment contracts (ECs) (2020: 19,644 FTEs). The additional expenditure on personnel was primarily a direct result of financing additional posts (+425 FTEs, +2%). Part of the additional personnel expenses was used to manage the payroll system and to increase employer contributions for social security and pension provision.

The bulk of the financing for full-time equivalents is accounted for by the total federal contribution (2021: 12,764 FTEs). In 2021, CHF 1,740m was spent according to the statistical survey and is charged to the total federal contribution (federal financial contribution). The number of FTEs financed by the total federal contribution rose by 157 compared with 2020. The research contributions of the Federal Government and the EU FPs financed 4,725 FTEs. The funds stemming from cooperation with the private sector and from donations/bequests are allocated for 2,580 FTEs. Compared with 2020, there was a particular increase in the latter full-time equivalents financed from third-party funding (+318 FTEs or +14%).

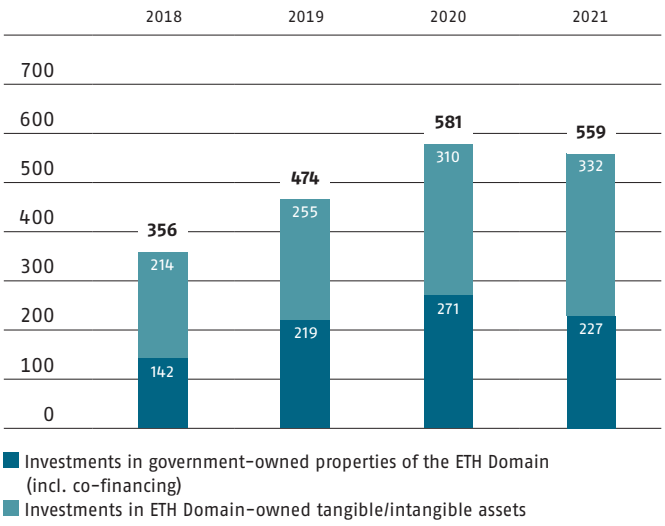
The employer contributions in relation to salaries and wages (not allowing for IPSAS 39) stood at 20.6% in 2021. The 2021 budget calculations included a flat-rate employer contribution of 21.55% in line with Federal Government practice (Federal Office of Personnel, FOPER). The effective contribution rate for 2021 was thus lower than the contribution rate used for the calculation.

Investments
All investments are shown under the total investments, irrespective of ownership and their financing, i.e. they are the investments in the building stock used by the ETH Domain.

The investment volume was slightly lower than in the previous year (2021: CHF 559m; 2020: CHF 581m). Development of the total investments is shown in Figure 32. There was less construction activity than in the previous year, but more was invested in property, plant and equipment instead, for example in the supercomputer of the CSCS (ETH Zurich) in Manno (Canton of Ticino), in equipment of the EPFL's Dubochet Center for Imaging and Empa's NEST and in the ATHOS beamline, and the start of the SLS 2.0 upgrade at the PSI. Leasehold improvements remained high even in the reporting period, capital was needed for, amongst other things, extensions on the Hönggerberg campus and Basel campus (D-BSSE) of ETH Zurich and on the Empa-Eawag campus.

The share of total investments, measured as a proportion of total expenses, was almost 15% and thus above the long-term average (approximately 12%), but within the usual range of the central Federal Administration (12 to 15% share of total expenses).

Fig. 32: Development of the total investments (in CHF millions)



Expenditure ceiling and credits

The ETH Domain's expenditure ceiling for the period from 2021 to 2024

In order to implement its strategic planning for the period from 2021 to 2024, the ETH Board requested for the ETH Domain in its financial requirements planning Ø annual growth of 3.1% (incl. 1% inflation), see 2021–2024 ERI Dispatch dated 26 February 2020/Federal Gazette 2020 3770. This had corresponded to an expenditure ceiling for 2021 to 2024 of max. CHF 11,053m.

Based on the Federal Government's financial planning and the priorities set in the ERI area, it was not possible to meet this demand to the extent expected. In the 2021–2024 ERI Dispatch, the Federal Council applied for an expenditure ceiling of CHF 10,810.7m (Ø annual growth: 2.5%, basis: expected budget for 2020, CHF 2,556.2m).

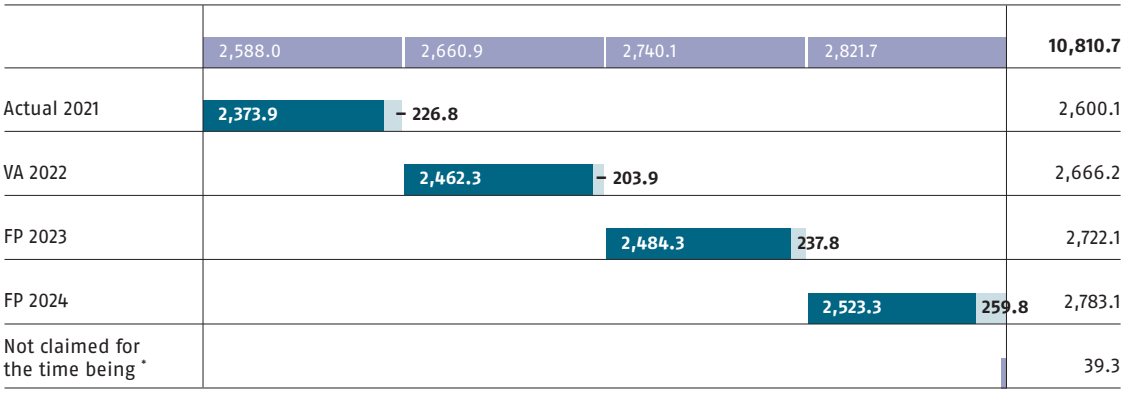
Figure 33 shows the expenditure ceiling and the loans for the ETH Domain in the ERI period from 2021 to 2024.

Approved credits in 2021

The annual total federal contribution allocated to the ETH Domain is made up of the expenditure credit (A231.0181: federal financial contribution) and the investment credit (A202.0134: investments in constructions of the ETH Domain). The Federal Assembly approved CHF 2,600.1m in FedD Ia for the 2021 budget for both credits which are credited against the expenditure ceiling. Compared with 2020 (CHF 2,596.1m), the increase was CHF 4.0m (+0.2%).

Fig. 33: Expenditure ceiling and loans for the ETH Domain in the ERI period from 2021 to 2024

CHF millions



* The provisional utilisation of the expenditure ceiling amounts to CHF 10,771.4m or 99.6%.

A231.0181 Federal financial contribution
A202.0134 Investments in constructions of the ETH Domain

Consolidated financial statements

Table 1: Statement of financial performance of the ETH Domain (consolidated)

CHF millions	Notes	Budget 2021	Actual 2021	Actual 2020	Change to Actual absolute
Federal financial contribution		2,373	2,373	2,355	18
Federal contribution to accommodation		230	230	244	−14
Total federal contribution	**7**	**2,604**	**2,604**	**2,600**	**4**
Tuition fees, continuing education	**8**	**56**	**56**	**50**	**6**
Swiss National Science Foundation (SNSF)		270	268	263	5
Swiss Innovation Agency (Innosuisse)		51	41	51	−9
Special federal funding of applied research		84	87	80	7
EU Framework Programmes for Research and Innovation (EU-FPs)		156	160	146	14
Industry-oriented research (private sector)		151	136	136	–
Other project-oriented third-party funding (incl. cantons, municipalities, international organisations)		85	95	98	−3
Research contributions, mandates and scientific services	**9**	**798**	**788**	**774**	**14**
Donations and bequests	**10**	**79**	**122**	**142**	**−19**
Other revenue	**11**	**122**	**127**	**114**	**13**
Operating revenue		**3,658**	**3,697**	**3,680**	**17**
Personnel expenses	5, 12, 28	2,343	2,426	2,490	−64
Other operating expenses	13	958	893	885	8
Depreciation	21, 23	252	266	255	11
Transfer expenses	14	149	56	51	4
Operating expenses		**3,702**	**3,641**	**3,682**	**−41**
OPERATING RESULT		**−44**	**56**	**−3**	**59**
NET FINANCE INCOME / EXPENSE	**15**	**−3**	**26**	**11**	**15**
Share of surplus / deficit of associated entities and joint ventures	20	–	28	32	−4
SURPLUS (+) OR DEFICIT (-)		**−47**	**110**	**41**	**69**

Table 2: Balance sheet of the ETH Domain (consolidated)

CHF millions	Notes	31.12.2021	31.12.2020	Change absolute
CURRENT ASSETS				
Cash and cash equivalents	16	1,862	1,968	–106
Current receivables from non-exchange transactions	17	637	616	21
Current receivables from exchange transactions	17	73	60	14
Current financial assets and loans	22	488	464	25
Inventories	18	12	10	2
Prepaid expenses and accrued income	19	70	63	7
Total current assets		**3,143**	**3,181**	**–38**
NON-CURRENT ASSETS				
Property, plant and equipment	21	2,032	1,967	65
Intangible assets	21	60	62	–2
Non-current receivables from non-exchange transactions	17	979	971	7
Non-current receivables from exchange transactions	17	–	–	–
Investments in associated entities and joint ventures	20	271	242	29
Non-current financial assets and loans	22	64	52	12
Co-financing	23	114	118	–5
Total non-current assets		**3,518**	**3,412**	**106**
TOTAL ASSETS		**6,661**	**6,592**	**69**
LIABILITIES				
Current liabilities	24	168	189	–21
Current financial liabilities	25	14	19	–4
Accrued expenses and deferred income	26	179	151	28
Short-term provisions	27	105	108	–3
Short-term liabilities		**466**	**467**	**–1**
Dedicated third-party funds	29	1,605	1,608	–3
Non-current financial liabilities	25	327	335	–8
Net defined benefit liabilities	28	615	1,087	–473
Long-term provisions	27	604	610	–6
Long-term liabilities		**3,150**	**3,640**	**–489**
Total liabilities		**3,616**	**4,106**	**–490**
EQUITY				
Valuation reserves		424	–27	452
Reserves from associated entities	20	271	242	29
Donations, grants, co-financing*		953	912	42
Other equity*		1,397	1,360	37
Total equity		**3,045**	**2,486**	**559**
TOTAL LIABILITIES AND EQUITY		**6,661**	**6,592**	**69**

* The 2020 values do not correspond to the values published in the Financial Report 2020. They have been restated due to the retrospective amendment of the accounting and recognition requirements for the reserve categories newly defined in 2021. See the section "Restatement of prior-year figures" in Annex 2.

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Rounding differences: The financial totals or figures presented in this document may not correspond precisely to the amounts shown in the tables. These amounts are calculated on the basis of nonrounded figures and may differ from a value based on rounded figures shown in the tables.

All photos of people for the reports in the chapter Fascination ETH Domain (p. 11–34) were taken in strict compliance with the measures relating to social distancing and the obligation to wear a mask, with the involvement of as few people as possible.

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- the members of the ISP Group of the ETH Domain (Implementation of Strategic Planning),
- the members of the ETH Domain ComTeam (Heads of Communication and their staff),
- the departmental heads and employees of the ETH Board staff and of the institutions of the ETH Domain

ETH BOARD

The ETH Domain consists of the two Swiss Federal Institutes of Technology ETH Zurich and EPFL, and the four federal research institutions, the Paul Scherrer Institute (PSI), WSL, Empa and Eawag. Appointed by the Federal Council, the ETH Board is the strategic governing and supervisory body of the ETH Domain.

www.ethboard.ch

The Institutions of the ETH Domain:

ETH Zurich
520 professors, 23,900 students, 3,000 administrative and 6,400 scientific staff from over 120 countries: they all research, teach, learn and work at ETH Zurich. Networked globally with the scientific community, and rooted in Switzerland via National Centres of Competence in Research. More than 5,000 young people graduate every year, bringing the latest knowledge to Swiss companies. Or they found one of the 30 or so spin-offs established each year in industries with a promising future like nanotechnology, medtech, cybersecurity or computer science. www.ethz.ch

EPFL
EPFL is one of the most international technical universities. It hosts over 12,000 undergraduate students and doctoral students from over 120 countries. It has more than 370 laboratories conducting leading research in areas such as renewable energy, medical technology, neurotechnology, materials science and computer science. EPFL cooperates with an important network of partners, including representatives from other universities, industry and business, politics and the general public, in order to have a real influence on society. In 2021, a total of 32 spin-offs emerged from EPFL which equates to more than two per month. www.epfl.ch

PSI
The Paul Scherrer Institute (PSI) develops, builds and operates large-scale and complex research facilities, which it makes available for use by the national and international research community. All of these large-scale research facilities are unique in Switzerland, and in some cases the PSI is the only place in the world to have them. The institute's own research focuses on the fields of matter and materials, energy and the environment, as well as humanity and health. www.psi.ch

WSL
WSL investigates changes to the terrestrial environment and the use and protection of natural habitats and cultural landscapes. It monitors and researches the condition and progress of forests, landscape, biodiversity, natural hazards and snow and ice, and develops sustainable solutions for socially relevant problems. WSL also includes the WSL Institute for Snow and Avalanche Research SLF Davos. www.wsl.ch

Empa
Empa is the interdisciplinary research institute of the ETH Domain for materials science and technology. On the basis of its research, it develops solutions to meet the biggest challenges currently facing industry and society, and therefore plays a significant role in reinforcing the innovative capacity and competitiveness of Swiss industry in an increasingly competitive environment. www.empa.ch

Eawag
Eawag is one of the world's leading water research institutes. Its strength and success are based on the combination of research, teaching and further education that it has provided for over 80 years, along with consultancy and the transfer of knowledge. The combination of natural sciences, engineering and social sciences enables comprehensive research into water in relatively untouched rivers and lakes, right through to waste water management systems. www.eawag.ch

Cover page
ETH Zurich professors, Andreas Wallraff (left) and Lukas Novotny (see also p. 15), are expanding their teaching and research activities in the field of quantum science.

Back page
On the trail of natural toxins in the Greifensee: Eawag researcher Elisabeth Janssen (centre) with technician Thea Bulas (left) and Jonathan Held, who is doing civilian service and helping to take samples (see also p. 32).

ETH Board
Board of the Swiss Federal
Institutes of Technology

Zurich:
Häldeliweg 15
8092 Zurich
Switzerland

Bern:
Hirschengraben 3
3011 Bern
Switzerland

www.ethboard.ch