ETH zürich

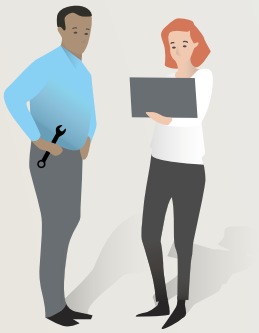
Annual report **2017**

The challenge: to develop a zero-emission capsule that could one day transport people and goods through a vacuum tube at almost the speed of sound, and test it in a race sponsored by Elon Musk – while at the same time studying for a Bachelor's degree in mechanical engineering at ETH. Not a problem for the multitalented **Luca Di Tizio**, just 23 years old. He was project leader of Swissloop in 2017, and has many different interests. He decided to study mechanical engineering at ETH because it will open up many interesting opportunities in fields like medical technology and consulting. A Swiss citizen with Italian roots, this scientist is also a very keen athlete.

ETH Zurich – Where the future begins

20,600 students, including **4,100** doctoral students, from **120** countries

530 professors



5,960 scientific staff*
2,660 technical and administrative staff*

21 Nobel Prize winners (including Albert Einstein and Wolfgang Pauli)
2 Pritzker Prize winners
1 Fields Medal winner
1 Turing Award winner

CHF **1.9 billion,** including CHF **1.4 billion** total contribution from the federal government

380 spin-offs since 1996

200 invention disclosures,
90 patent applications and
80 licences every year

10th in THE ranking
10th in QS ranking
19th in ARWU ranking

* full-time equivalents (FTEs)

Freedom and individual responsibility, entrepreneurial spirit and open-mindedness: ETH Zurich stands on a bedrock of true Swiss values. Our university for science and technology dates back to the year 1855, when the founders of modern-day Switzerland created it as a place of innovation and knowledge. At ETH Zurich, students discover an ideal environment for independent thought, researchers a climate which inspires top performance. Situated in the heart of Europe, yet connected all over the world, ETH Zurich is developing skillful solutions to the global challenges of today and tomorrow.

"Society rightfully expects ETH to identify the trends, opportunities and risks of the coming decades, and to respond to them proactively."

From the silicone heart being developed in the Zurich Heart project to the house constructed by robots and advances in internet security: the sheer breadth and depth of our university's research activity is very impressive. The pioneering work done at ETH Zurich over the past year is only possible thanks to highly motivated people working together towards a common goal: professors, assistants and doctoral students, as well as technical and administrative staff. My special thanks go to all members of our ETH community who contribute so much to university life on a daily basis.

It was in 2017 that digital transformation finally became a major talking point in Swiss politics, the media and society. ETH has attracted new teaching and research talents to ensure that Switzerland will be able to take full advantage of the opportunities created by this transition.

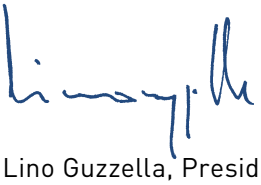
The Swiss Data Science Center launched in 2017 by the ETH Domain has a key role to play here. A new Master's programme in data science, as well as the Bachelor's course in human medicine, are further milestones in the continuing development of our curriculum. For the first time, 20,600 students – 4,100 of them doctoral candidates – chose ETH as their preferred institute of higher education.

As a technical university, we strive to make the results of our research available to industry and society as quickly and effectively as possible. Over 300 collaborations with Swiss industry and 25 new spin-off companies are testament to this sharing of knowledge and technology transfer. Community outreach events like Scientifica and Treffpunkt Science City ensure that we, as academics and scientists, stay attuned to the daily lives of Swiss people.

Society rightfully expects ETH – one of the world's leading universities – to identify the trends, opportunities and risks of the coming decades, and to respond to them proactively. The Executive Board, with the support of faculty members, has risen to this challenge by launching the ETH+ project, whose mission is to secure the university's leading position for the future.

It remains for me to thank everyone who supports ETH – taxpayers and politicians, donors, as well as the decision-makers in industry and public office – for the trust they have once again placed in our university over the past year.

I hope you enjoy reading this year's annual report.



Lino Guzzella, President of ETH Zurich

Highlights 2017

1

1 Switzerland's digital day

The first nationwide Digitaltag was held on 21 November 2017. It gave ETH the opportunity to showcase numerous projects and offer a programming workshop for kids. ETH President Lino Guzzella also joined in the public discussion on the opportunities that digital transformation presents for Switzerland. → page 37

2 Globi at ETH

Our own university provides the setting of the latest adventure of Switzerland's most famous comic book hero, bringing the fascinating world of ETH into children's bedrooms. In March 2017, ETH held the official launch party for the 87th volume in the Globi series at the *focus*Terra Earth Science Research and Information Centre. → page 36


2

3 Human medicine

In Autumn Semester 2017, the first 100 students began their Bachelor's course in human medicine at ETH Zurich. The new course not only focuses on mainstream clinical medicine, but also delves into areas such as molecular biology and medical technology. → page 10

4 ETH+

At the ETH Faculty Retreat in Lucerne on 10–11 November, the Executive Board, professors and members of management from the central administrative units discussed new avenues of cooperation and opportunities to expand the university's teaching and research capacities, as well as ways to improve knowledge and technology transfer. These will be collectively developed and implemented over the coming years as part of the ETH+ programme. → page 65

5 A silicone heart

ETH researchers from the Functional Materials Laboratory have developed a silicone heart whose shape and functionality closely resemble those of a human heart. The soft artificial heart, made from silicone by a 3D printer, beats almost like the real thing. → page 27

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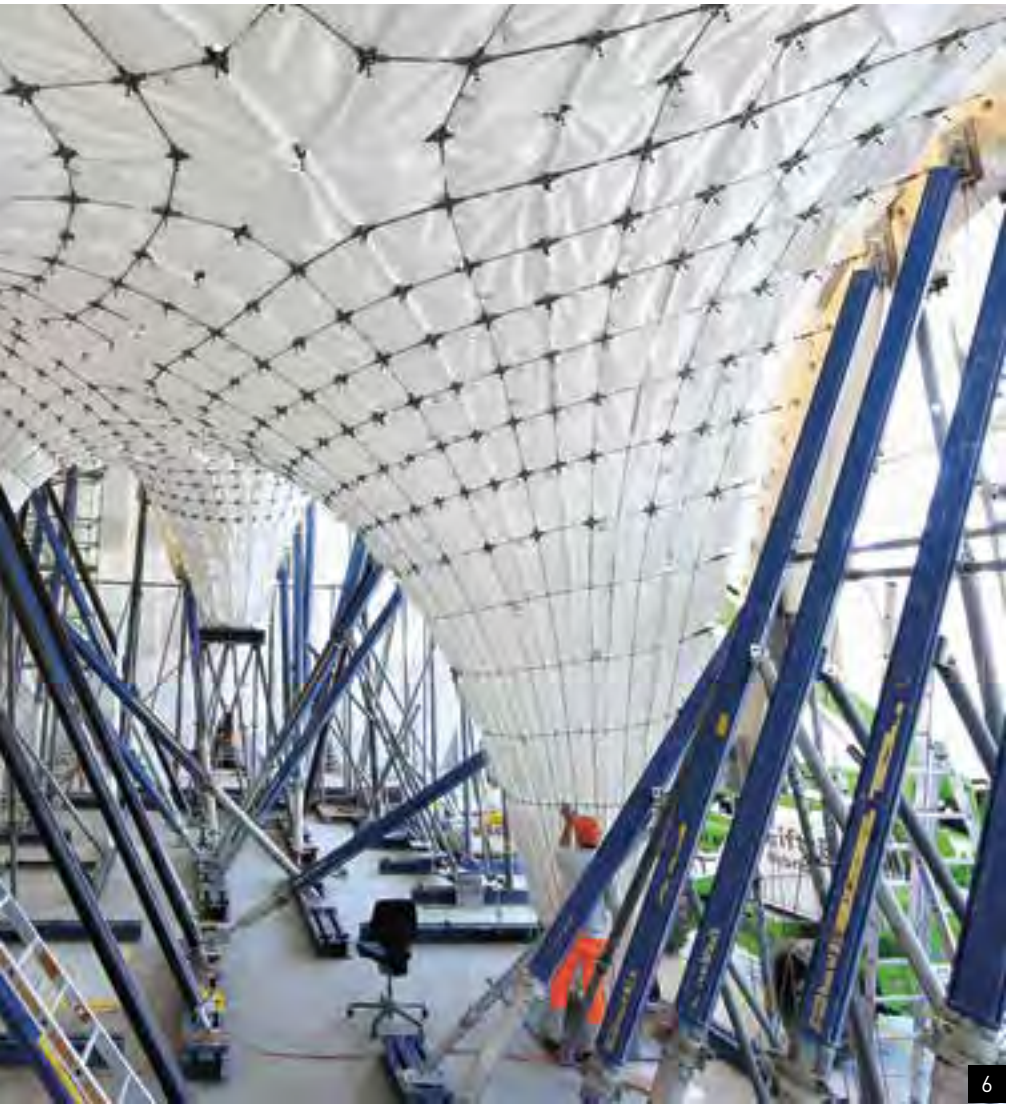


6 HiLo

Using innovative digital design and fabrication methods, ETH researchers have built the prototype of an ultra-thin, curved concrete roof. The shell is part of a rooftop apartment unit called HiLo due to be built in 2018 on the NEST, the living lab building in Dübendorf. → page 26

7 Swissloop

Fifty students from ETH and other Swiss universities came third in the Hyperloop pod competition organised by Elon Musk. To compete in the race, they developed a zero-emission capsule that could in future transport people and goods through a vacuum tube at almost the speed of sound. → page 17

8 AgroVet-Strickhof

ETH Zurich, the University of Zurich and the canton of Zurich held an official opening ceremony on 1 September 2017 at AgroVet-Strickhof, a centre for practical collaboration in the livestock sector. The state-of-the-art facilities will allow the participating ETH professorships to conduct interdisciplinary research with direct links to agricultural practice. → page 64


9

9 Industry Day

Around 600 representatives from industry and business met with scientists for exciting discussions at the Industry Day event. New research findings and networking were the order of the day. → page 32


10

10 ETH at the WEF

ETH Zurich staged a public exhibition at the World Economic Forum (WEF) annual meeting for the first time in 2017, using the opportunity to present the university's latest research findings and network with representatives from a number of leading universities, international organisations and the world of business. → page 32

11 Scientifica

The fifth biennial Scientifica event organised by ETH Zurich and the University of Zurich was a resounding success. Over 30,000 visitors came along at the weekend to discover more about what data reveal. Around 300 researchers from both universities were on hand to give talks and answer questions. → page 37


11

She is one of those mathematicians who apply their knowledge to solve problems in the real world, such as the evolution of species or how epidemic infectious diseases such as Ebola and HIV emerge and spread. Like a palaeontologist, **Tanja Stadler** tries to understand what happened in the past in order to make predictions about the future. Rather than digging for fossils, however, she uses genetic information, mathematical models and statistical skills. In 2017, this German-born scientist was appointed Associate Professor of Computational Evolution at ETH Zurich at the age of just 36. She has already won an ERC Starting Grant for her work, along with several other major accolades, such as the ETH Zurich Latsis Prize.

Teaching

ETH Zurich has expanded its course content in two key areas: in partnership with other institutions, it now offers a Bachelor's degree in human medicine that combines aspects of clinical medicine with natural sciences and medical technology. The aim of the new Master's programme in data science is to train specialists capable of extracting valuable information from vast quantities of data (big data). This expanded range of study courses is also reflected in the latest student numbers: enrolment for Autumn Semester 2017 hit a new record of more than 20,000 students.

The rapid transformation of our society and economy is also changing the labour market. ETH Zurich is responding to these changes by offering a very diverse range of continuing education courses. A total of 11 new programmes ran for the first time in 2017, including the Master of Advanced Studies ETH Mediation in Peace Processes and the Certificate of Advanced Studies ETH ARC Digital.

ETH is also breaking new ground in its examination formats: in future years, the university plans to expand its range of online exams. At the same time, students are to receive more regular feedback on the progress of their studies during term time.

Hands-on experience: in their very first week, students enrolled in the Bachelor's course in human medicine learn how to suture a wound.

NEW COURSES OF STUDY

Medicine and data science

For the first time in its history, ETH Zurich is offering a Bachelor's degree course in human medicine, an innovative study programme that combines medicine with natural sciences. The university is also launching a new Master's programme in data science.

One hundred students have already enrolled in ETH's new Bachelor's degree course in human medicine. After their Bachelor's degrees, they will transfer to the medical faculties of the universities of Zurich, Basel or Lugano to complete their training, so they must also pass the aptitude test required for studying medicine that is set by swiss-universities. This is a novelty for ETH, as no other courses have had admission restrictions (numerus clausus).

Medicine of the future

The purpose of ETH's new programme is to complement the existing range of medical studies and not only impart medical knowledge to students, but also give them a deeper understanding of natural sciences and medical technology. Such knowledge will be needed to deal with new approaches and technologies, such as personalised medicine, which many experts consider to be the medicine of the future. The course is based on a combination of medicine, biology and computer science. In future, genetic analysis should enable medical treatments to be customised for individual patients.

There are currently 100 places on this course, which is run by the Department of Health Sciences and Technology. After completing their Bachelor's degrees, the students transfer to one of three partner universities for their Master's in medicine, as ETH does not have its own teaching hospital. The new study programme was only made possible through close cooperation with three key partners: the University of Zurich, University of Basel and Università della Svizzera Italiana (USI) in Lugano. They guarantee places for Master's students and accept ETH graduates with no further admission requirements. After six years of training, students are finally eligible to take the Swiss federal exam – just like their medical colleagues across the country.

Plus a new data science course

2017 also saw the rollout of a new Master's programme in data science, with 22 students

Students have their first experience of ultrasound equipment at Baden cantonal hospital.

enrolled for the first semester. The purpose of this course is to teach ETH specialists how to extract valuable information from ballooning volumes of data worldwide. Here the university sees its role as helping to shape the digital future of Switzerland, which has the chance to become a powerhouse in the field of information technology. The Master's degree in data science is offered jointly by three departments: Computer Science, Mathematics, and Information Technology and Electrical Engineering.

Interpreting digital data

Data science is used in many different professional fields. For example, it can be applied to machine learning in manufacturing technology, producing forecasts in environmental science or analysing patient data in personalised medicine.

The new Master's programme offers comprehensive training for the next generation of data scientists. In this degree course, students learn about the management and storage of vast quantities of data, and the development of efficient algorithms for data analysis. A core element of the study programme is the Data Science Laboratory, where students have the opportunity to solve specific, practical problems arising in interdisciplinary applications. ■

www.ethz.ch/humanmedizin
www.inf.ethz.ch/studies/master/master-ds.html

ETH Zurich sees its role as helping to shape the digital future of Switzerland and is offering a new Master's course in data science.

The CAS ETH ARC Digital course teaches the principles of sustainable construction.

CONTINUING EDUCATION

Preparing for a world in flux

Global changes and megatrends present new challenges for business and society. ETH Zurich is responding to these with a very diverse offering in the area of continuing education.

Globalisation and digitalisation bring profound and lasting changes to the way we live and work. In such an environment – where the key to survival is the willingness to take on new challenges – continuing education is becoming more and more important. This applies not only to the ongoing professional and personal education of individuals, but also to the further development of companies and entire economies.

ETH Zurich is responding to this demand, and to industry's and society's expanding requirement of additional qualifications, by providing a very diverse range of continuing education courses that attract thousands of people every year. In 2017 ETH Zurich's course offering included 18 Masters of Advanced Studies (MAS), 7 Diplomas of Advanced Studies (DAS) and 17 Certificates of Advanced Studies (CAS), as well as some 50 further education courses, over two dozen online courses and 8 massive open online courses (MOOCs).

MAS ETH Mediation in Peace Processes

In Autumn Semester 2017, ETH launched a new MAS course, Mediation in Peace Processes, developed in close collaboration with the Swiss Federal Department of Foreign Affairs (FDFA). Building on Switzerland's tradition of providing diplomatic mediation and "good offices", this course trains specialists in mediation processes for international conflicts, helping to improve and professionalise the training of mediators working for peace. Conflict analysis, mediation techniques and negotiating tools are just some of the topics studied.

CAS ETH ARC Digital

ETH is adopting a number of measures in response to the megatrend of digitalisation. For example, it has launched a new architecture course, CAS ETH ARC Digital, aimed at professionals with previous experience in architecture, construction, real estate or technology. This complements the existing MAS ETH Architecture and Digital Fabrication programme launched two years ago. The first students to enrol in this part-time course graduated in 2017.

To combine and communicate offerings more effectively in future, the Executive Board has approved a new road map for continuing education, starting in 2018. The idea is that study courses and programmes will in future be more closely aligned to target groups and stakeholders. ■

www.ethz.ch/continuing-education

STUDENT ASSESSMENTS

Exams under revision

Examinations influence the teaching format and students' motivation. For this reason, ETH is continuously developing not only its course content, but also its exams. For example, it is extending online examinations and encouraging more feedback on students' learning progress.

ETH is increasingly using online exams. These offer a wide variety of question formats and also provide a secure environment for skills-oriented performance assessments.

The way exams are set has a significant influence on what students learn, and how they learn it. The university therefore regularly reviews its own examination methods.

In 2017, around 100 participants from departments, university groups and Academic Services discussed the ongoing development of examinations in a closed session. Among other things, the concept of "learning tasks" emerged from the discussion. These are intended to give students regular and accessible feedback on their learning progress and motivate them to assimilate the course material as the semester progresses. Examples of learning tasks that complement the classical session examinations are short exercises corrected in class, quizzes and presentations of solutions to exercises.

ETH leads the way in online exams

There is growing demand for digital skills, and they are now playing an increasingly important role in teaching as well. ETH is making greater use of online exams to test these skills in an educationally relevant way. Programming exercises, CAD designs and statistical analyses can therefore be assessed in a realistic environment using all the possibilities offered by digitalisation. Online exams can also be corrected more quickly and efficiently. This considerably lightens the workload of lecturers, given the steady rise in student numbers.

ETH Zurich plans to more than triple its capacity for online exams over the next five years up to 2022. ETH is already playing a pioneering role in skills-oriented online assessments. Every year the university sets over 100 online tests for more than 10,000 students enrolled in some 70 different courses. Almost half of these assess individual skills in a way that would not be possible with traditional pen-and-paper methods.

The online exams are carried out using the Safe Exam Browser (SEB), a secure browser application. During the exam, software prevents a student from using restricted resources or communication media, and controls access to specific support tools and programmes. The SEB was launched in 2008 as an open-source project at ETH and has been extensively developed since then. In 2016 ETH joined forces with SWITCH, the combined technology and services platform for Swiss universities, to form the SEB Consortium, whose task is to provide long-term funding of the software so as to satisfy growing demand for online examinations.

Exam schedule under review

In addition to the assessment format, the timing of examinations can also have a considerable impact on academic success. First-year exams in particular seem to be a major hurdle for many students. Around 15 percent of Bachelor's students drop out of their studies before this basic examination. Launched in autumn 2016, a four-year pilot project is underway in five departments: Health Sciences (courses in medicine), Computer Science, Information Technology and Electrical Engineering, Mathematics, and Physics. Its purpose is to show whether splitting assessment into two exam blocks might help to encourage more students to take the first-year exam by providing feedback earlier on that will allow them to optimise their learning strategy. In all, 81 percent of students have taken advantage of this opportunity and took the initial part of their first-year exam already in their first semester. Success rates vary in the five departments. The results are being analysed in detail to further refine the examination system.

The students themselves are also regularly involved in the continuing development of teaching and exams, by completing surveys. They had the opportunity to evaluate all written exams for the first time in autumn 2015 and spring 2016. The university analysed the results of this survey in early 2017: The overall feedback was positive, with the general conditions, the exam procedure and the standardised parameters all considered to be particularly positive aspects. ■

www.ethz.ch/education

More than specialist knowledge
Simply recalling, understanding and applying specialist knowledge is not enough these days. Skills such as critical analysis and networked thinking play an increasingly important role in professional life. ETH Zurich already responded to this some years ago by launching the Critical Thinking initiative, which is designed to encourage critical reflection in the student's own discipline and promote interdisciplinary discourse. This initiative has produced a diverse palette of activities, ranging from courses such as ETH Week to facilities like the Student Project House (SPH; see the articles on page 16).

IT INCREASINGLY POPULAR

20,000 and counting

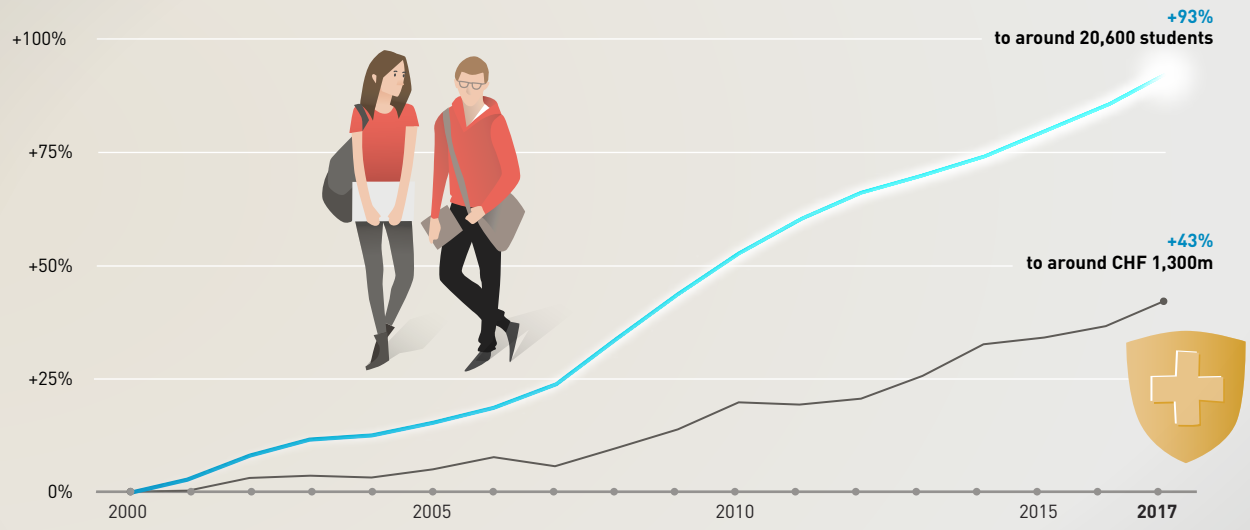
The number of students enrolled at ETH Zurich passed the 20,000 mark for the first time in 2017. The total student population – including Bachelor's and Master's, doctoral, continuing education, visiting and exchange students – reached a new record of 20,607, a 4 percent increase on the previous year. The percentage of women enrolling in undergraduate degree programmes for the first time remained at last year's level of 33 percent, while the proportion of first-year students who achieved their university entrance qualification in a foreign country rose slightly, from 12 to 13 percent.

In 2017 the number of young men and women who enrolled in one of the university's 23 undergraduate courses for the first time increased by 5 percent to a new high of 2,918 (2016: 2,780). As in previous years, the most popular undergraduate course continues to be Mechanical Engineering, with 475 new students. The number of undergraduates studying Computer Science and Physics also jumped significantly, with 324 and 244 new entrants, respectively. This development continues the trend of the past five years, during which Computer Science has seen a gain of 100 percent, followed by Maths including Computational Science and Engineering (76 percent), Chemistry (44 percent), Physics (34 percent) and Pharmaceutical Sciences (30 percent). Most ETH graduates (96 percent) continue their studies on one of the ETH Master's programmes. Due to the increase in student numbers, the faculty–student ratio has deteriorated slightly over the years. In 2017, one professor on average supervised 42 students from all categories (2000: 32; 2008: 39). ■

www.ethz.ch/academic-services

The number of new Bachelor's students in computer science keeps climbing, with a 100 percent increase in just five years.

Trend in student numbers and federal financial contribution since 2000



Students and degree awards

Students	Total		Bachelor's students		Master's students		Doctoral students		MAS/MBA students		Visiting/ exchange students	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Headcount	**19,815**	**20,607**	**8,934**	**9,262**	**5,836**	**6,158**	**4,010**	**4,092**	**635**	**646**	**400**	**449**
Percentage women	31.1%	31.8%	30.7%	31.2%	30.5%	31.6%	31.2%	31.7%	40.3%	41.0%	34.3%	36.1%
Percentage international students	38.2%	38.7%	19.3%	19.9%	40.6%	40.7%	70.8%	71.4%	40.9%	41.8%	93.8%	94.7%
Total registrations	**20,331**	**21,102**	**9,364**	**9,671**	**5,836**	**6,166**	**4,014**	**4,092**	**717**	**724**	**400**	**449**
Architecture and Civil Engineering	3,537	3,587	1,766	1,674	1,159	1,258	412	437	119	127	81	91
Engineering Sciences	7,065	7,430	3,403	3,547	2,137	2,280	1,365	1,405	15	18	145	180
Natural Sciences and Mathematics	5,144	5,307	2,348	2,511	1,297	1,346	1,176	1,144	232	209	91	97
System-oriented Natural Sciences	3,695	3,828	1,797	1,889	912	939	810	836	118	115	58	49
Management and Social Sciences	890	950	50	50	331	343	251	270	233	255	25	32
New students	**7,187**	**7,446**	**2,780**	**2,918**	**2,529**	**2,544**	**940**	**993**	**273**	**292**	**665**	**699**
Architecture and Civil Engineering	1,166	1,241	456	424	440	502	74	110	68	90	128	115
Engineering Sciences	2,466	2,627	982	1,046	919	935	302	343	2	8	261	295
Natural Sciences and Mathematics	1,881	1,901	770	842	612	595	287	258	68	48	144	158
System-oriented Natural Sciences	1,348	1,317	553	593	458	389	215	207	28	40	94	88
Management and Social Sciences	326	360	19	13	100	123	62	75	107	106	38	43
Country of education												
Switzerland	13,485	13,921	8,133	8,373	3,647	3,838	1,217	1,220	456	461	32	29
EU	4,717	4,847	1,058	1,099	1,396	1,428	1,861	1,901	168	157	234	262
Rest of Europe	469	516	103	114	156	179	178	179	18	20	14	24
Asia	1,090	1,207	46	56	444	504	477	508	47	52	76	87
America	453	479	20	23	158	170	222	228	21	25	32	33
Africa	80	83	3	4	23	28	44	43	4	5	6	3
Australia and New Zealand	37	49	1	2	12	19	15	13	3	4	6	11

Degrees and diplomas	Total		Bachelor's degree		Master's degree		Doctorate		MAS		Teaching diploma/ MAS SHE		Teaching certificate	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Degrees	**4,711**	**4,777**	**1,571**	**1,606**	**2,015**	**2,072**	**851**	**827**	**203**	**182**	**43**	**62**	**28**	**28**
Architecture and Civil Engineering	897	918	318	373	397	381	100	79	82	85	0	0	0	0
Engineering Sciences	1,466	1,545	524	537	691	733	246	265	0	0	0	4	5	6
Natural Sciences and Mathematics	1,213	1,183	358	365	527	506	283	268	16	4	28	40	1	0
System-oriented Natural Sciences	886	896	356	318	315	355	173	170	5	13	15	18	22	22
Management and Social Sciences	249	235	15	13	85	97	49	45	100	80	0	0	0	0

www.ethz.ch/student-stats

ETH AS A TALENT FACTORY

Providing expertise for the Swiss labour market

A total of 86 percent of Bachelor's students enrolled at ETH Zurich have been through the Swiss education system. Their initial year of study at ETH is quite demanding and culminates in first-year examinations. Around 35 percent of students leave the university without finishing their undergraduate degree, with almost half of those abandoning their studies before the first-year examinations. Fortunately, 90 percent of all students who pass their first-year exam go on to successfully complete their Bachelor's degrees.

95 percent progress to an ETH Master's

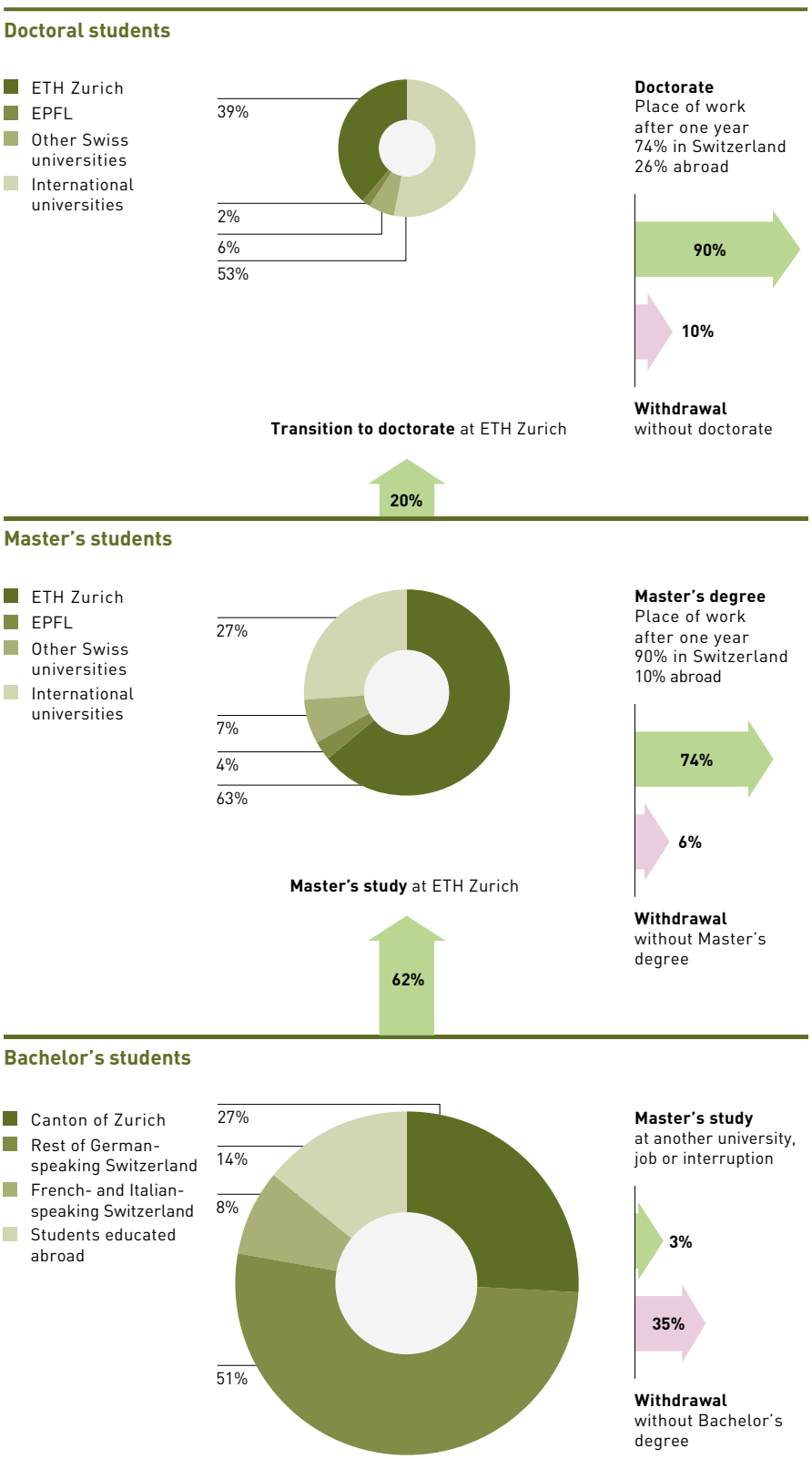
Most ETH students who finish their Bachelor's degrees then carry on to a Master's course at the university, with 95 percent following this progression. They account for around two thirds of all Master's students. A quarter of students come from international universities, with more than 3,000 students from abroad applying for an ETH Master's course this year.

The average period of study for completing both a Bachelor's and Master's degree is 11 semesters, while the Master's programme generally takes 4 semesters for students without a Bachelor's degree from ETH. Students on the Master's programme have a success rate of 94 percent. Most of the students graduating from the university bring their knowledge and skills into the Swiss employment market. A fifth of Master's graduates take their education a stage further by pursuing their doctorate at ETH.

International doctorate

Graduates from ETH Master's programmes make up around 40 percent of all doctoral students. The other 60 percent or so come mainly from foreign universities. Well over three quarters of doctoral students are employed as scientific staff at ETH.

Some 90 percent of ETH doctoral students successfully complete their doctorates at ETH after an average of four and a half years. Although more than half of them come from abroad, 74 percent go on to work in Switzerland after completing their doctorate.



Student data based on the average for the period 2012–2017; study success: matriculation cohorts 2006–2011 (Bachelor's, doctorate) or 2007–2012 (Master's); study duration: graduating cohorts 2012–2016; graduates' place of work one year after completing their studies: average of graduates of the years 2010, 2012 and 2014 from the FSO graduate survey.

FIRST SPH INNOVATION CHALLENGE

Developing your own ideas

The Student Project House (SPH) is a workshop where students can develop their own ideas. In 2017, the university held the first SPH Innovation Challenge in the Student Project House on the Hönggerberg campus. Over the course of a week, 25 students working in six multidisciplinary teams each chose a project idea and developed it into a prototype. The ideas generated during the week included an app for building managers and data glasses as an aid to learning physics terms.

Multidisciplinary approach

The purpose of this event is to improve students' ability to develop their own ideas and put them into practice in multidisciplinary project teams. While the Student Project House provided the space, materials and equipment (such as 3D printers) for the project development process, students also received expert support from the university's Spark Labs team. These experts gave an introduction into design thinking, an innovative approach that relies heavily on teamwork and develops solutions from the user's perspective. In future this challenge will be organised once every semester. ■

www.sph.ethz.ch

ETH WEEK 2017

Manufacturing the Future

A total of 180 students from 16 departments wrestling with socially relevant topics: that, in a nutshell, is ETH Week. The purpose of this event is not only to impart knowledge, but also to foster creative and critical thinking, along with interdisciplinary teamwork. In this third event in the series, participants got to grips with the topic Manufacturing the Future.

Split into groups of ten and inspired by visits to companies and lectures given by experts, the students learned about factories, resources and human–machine interfaces. Their task was then to come up with their own solutions for the manufacturing technology of the future. Here, the biggest challenge proved to be firstly identifying a problem that they wanted to tackle, and secondly working as a team to find a solution. The students received support from around 100 experts, 6 professorships from different departments and a number of tutors especially trained for ETH Week.

At the end of the week, each group presented the results of their work. The majority sought to close gaps in production cycles or develop human-centred socio-technical systems. The results were judged by the students themselves. Their Student Choice Award went to a sustainable packaging concept where food such as meat could be covered with an edible layer of lipid proteins to protect it from bacteria. The layer converts into fat when heated. The Impact Award went to two recipients: one was for improved recycling of plastic waste through modified polymer crystals capable of storing information like a barcode, the other for a mirror with sensing technology for fashion shoppers. ■

www.ethz.ch/ethweek

ETH Week fosters stimulating discussions, here with ETH Rector Sarah Springman (2nd from left).

FIRST SCIENCE IN PERSPECTIVE TALK

Trust on the internet

ETH Zurich has launched a new series of talks: Science in Perspective. These tackle current scientific and technological themes with a social dimension, and are aimed at students, researchers, ETH employees and the public.

The talk series is linked to the Science in Perspective study programme offered by the Department of Humanities, Social and Political Sciences. This gives ETH students from a broad range of disciplines the opportunity to explore normative, historical and cultural perspectives in the fields of natural science and engineering. The topic of the first talk held in May 2017 was internet security. IT specialists and social scientists from ETH discussed how trust is built on the internet.

Encryption supports trust

Attending the talk was Stefan Bechtold, ETH Professor of Intellectual Property. He is researching why users do (or do not) trust the statements of people they have only chatted with online, and what is required to make the internet a more trustworthy space. The legal and IT experts agree that encryption technologies offer one approach to increasing trust. ■

www.gess.ethz.ch/en/news-and-events/sip-talk/sip-talk-1.html

SWISSLOOP

Transport of the future

Students from ETH Zurich, together with colleagues from the Lucerne University of Applied Sciences and Arts and the University of Applied Sciences and Arts Northwestern Switzerland, are researching the transport of the future. They have developed a capsule that could potentially transport people and goods through a vacuum tube at almost the speed of sound.

The Swissloop student team finished third in the Hyperloop Pod Competition.

Tesla founder Elon Musk wants to revolutionise transport – and has set up a student competition as an incentive that has attracted 1,200 teams from across the globe. A shortlist of 27 of the most promising teams were invited to the SpaceX headquarters in Los Angeles, where the transport capsules – known as pods – underwent rigorous testing over the course of six days. Only three student teams passed all the tests, earning the right to enter their pod in the final race on 27 August. Swissloop, a team comprising around 50 students from ETH Zurich and other Swiss universities, was among them. Their 3.5 m long, elegant white capsule finished in third place after some initial technical problems.

To achieve maximum propulsion for the pod, the young researchers opted for a combination of levitation and a cold gas thruster. The magnetic rails on the bottom of their pod produce eddy currents in the aluminium plate inside the tube as they are pushed across it. As a result, the pod begins to float. To accelerate the capsule, a cold gas thruster uses the pressure difference to shoot compressed air from the pod into the vacuum tube. This allows the capsule to reach a maximum speed of 400 km/h over the 1.25 km test track without generating emissions. Speeds of up to 1,200 km/h should be possible over longer distances. The Swissloop team members will continue to develop their pod after the competition. Their vision is to transport people and goods faster and more sustainably than ever before. ■

www.swissloop.ch

GOLDEN OWL AWARDS

Outstanding lecturers honoured

Semester feedback, course assessments, student surveys: ETH is keen to hear what students think about the teaching they receive. And feedback from students themselves is often the best way to keep standards high. For some years now, ETH Zurich's student association VSETH has presented the Golden Owl award to recognise exceptional teaching. One lecturer per department is selected for this honour. The 2017 winners are:

- Professor Vittorio Magnago Lampugnani (D-ARCH)
- Dr Falk Wittel (D-BAUG)
- Professor Annette Oxenius (D-BIOL)
- Professor Karsten M. Borgwardt (D-BSSE)
- Professor Antonio Mezzetti (D-CHAB)
- Professor Derek Vance (D-ERDW)
- Dr Carmen Ghisleni (D-GESS)
- Dr Rosmarie Clara (D-HEST)
- Dr Martin Hirt (D-INFK)
- Professor Johann Walter Kolar (D-ITET)
- Professor Torbjörn Netland (D-MTEC)
- Dr Quentin Lohmeyer (D-MAVT)
- Professor Markus Niederberger (D-MATL)
- Professor Wendelin Werner (D-MATH)
- Professor Renato Renner (D-PHYS)
- Dr Monika Maurhofer Bringolf (D-USYS)

All previous winners of the Golden Owl award are automatically nominated for the Credit Suisse Award for Best Teaching, which is presented by the Credit Suisse Foundation and VSETH. This award can only be won once during the course of a teaching career. Professor Vittorio Magnago Lampugnani from the Department of Architecture received the award in 2017. ■

www.ethz.ch/owl

Uwe Sauer is ETH Professor of Systems Biology and President of the ETH Zurich Research Commission, whose task is to support young talents at the start of their career and to encourage original research ideas that explore new scientific territory. As President, Sauer helps to determine the Commission's direction and is close to the current research hotspots. His own area of research expertise is the complex metabolic networks in microbes and higher cells. The group he leads, for example, has developed a method for analysing the concentration of hundreds of metabolic products simultaneously and almost in real time.

Research

ETH Zurich can look back on a highly successful year of research. The university's scientists have published important results in many areas. To take a few examples, they have acquired a better understanding of how vaccinations work, created an advanced microchip to improve medical diagnostics, conducted complex experiments to demonstrate the quantum physics phenomenon of supersolidity, created a silicone heart with a 3D printer and produced innovative building elements using robots. The success of ETH researchers is due in no small part to the ETH Zurich Research Commission, founded 75 years ago, which supports unconventional project ideas and promotes scientific talent.

Opportunities for interdisciplinary cooperation are an important element of scientific success. ETH is working to cultivate these opportunities at the Energy Science Center and the Competence Center for Materials and Processes – whose term has been extended until 2021 – as well as the new Swiss Data Science Center, which the university operates jointly with EPFL. The new Citizen Science Center Zurich, founded jointly with the University of Zurich, promotes unbureaucratic cooperation between researchers and non-scientists.

CENTRES OF EXCELLENCE

Energy, materials and citizen science

The university's Executive Board has approved a four-year extension for the Energy Science Center (ESC) and the Competence Center for Materials and Processes (MaP). A centre for citizen science has also been launched.

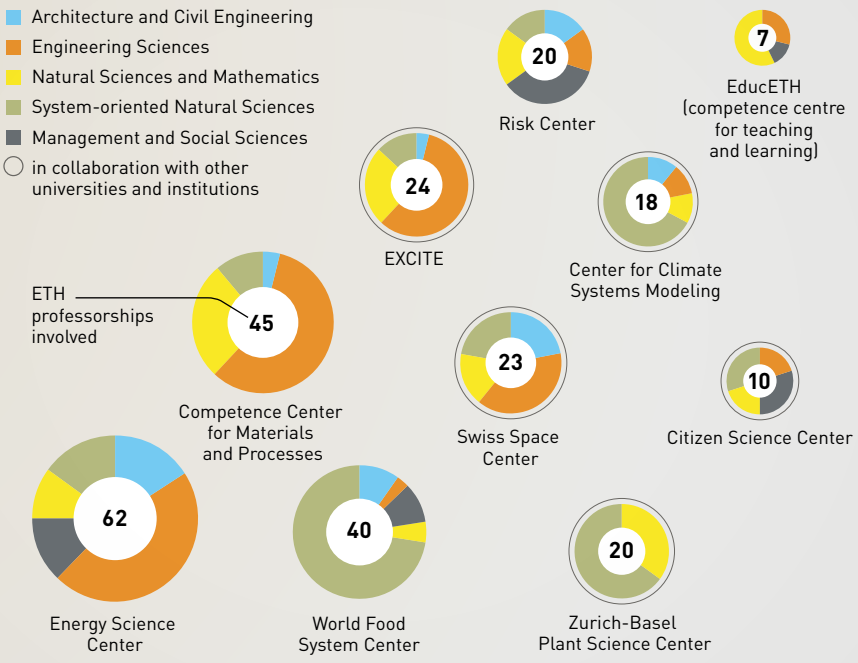
ETH Zurich established the Citizen Science Center jointly with the University of Zurich on 1 January 2017. The Center acts as an interface, providing non-scientists with an unbureaucratic way of participating in the universities' research projects, partly via special online networks. Today, for example, hundreds of thousands of laypeople help to analyse telescopic images of the sky and categorise galaxies.

The Executive Board has approved a four-year extension for the Energy Science Center (ESC). The ESC promotes research and teaching in the field of energy across disciplines and departments, and engages in dialogue with policy-makers and the business community. Over 60 professorships are currently involved in this venture. Key ESC projects for the coming years include the Renewables Management and Real-time Control Platform (ReMaP) and the Integrated Energy Systems Modelling Platform (Nexus). The design and operation of future energy supply systems are being tested and further developed as part of the ReMaP project. A dedicated data and control platform connects new technology demonstrators as well as existing research platforms at the Paul Scherrer Institute in Villigen and the Empa institute in Dübendorf.

The future of the Competence Center for Materials and Processes (MaP) is also assured until 2021. MaP combines over 70 professorships from different disciplines with a common interest in the research and development of new materials, technologies and industrial processes. A focal point during the new funding period is the development of personalised interdisciplinary training opportunities in the field of advanced materials and manufacturing technologies. MaP is also working to expand capacity within the ETH Board's strategic focus area of Advanced Manufacturing. ■

www.ethz.ch/research/centres

Centres of excellence at ETH Zurich



D-BSSE CELEBRATES TEN YEARS

D-BSSE well established in Basel

ETH established its first department outside Zurich, the Basel-based Department of Biosystems Science and Engineering (D-BSSE), in 2007. With its focus on systems biology and synthetic biology, the department has been perfectly matched to Basel from the start. "ETH Zurich was able to establish itself here at one of the world's largest life sciences clusters, with first-class researchers from the academic world and leading pharmaceutical companies," says Professor Timm Schroeder, head of the ETH department in Basel, on the occasion of D-BSSE's ten-year anniversary.

Today, the department has 19 professors and over 300 employees in total. The three areas of biology, engineering and theory remain the key pillars of the department. Personalised medicine, data science, molecular systems engineering and basic research are the strategic priorities for D-BSSE over the coming years.

The D-BSSE research community will be working together even more closely in future. Lack of space in the current main building has led to groups being spread over the Rosental campus. To unite all research groups under one roof, a new department building will be built over the next few years on the Schällemätteli campus close to the University of Basel.

SystemsX.ch draws to a successful close

At the same time as D-BSSE celebrates its anniversary, SystemsX.ch – the national research initiative to promote systems biology – is drawing to a close. Over nine years, the Swiss government has provided funding of 220 million Swiss francs to support 248 research projects involving more than 2,000 researchers from 15 different universities and research institutions working in interdisciplinary teams. SystemsX.ch has generated 1,420 publications, many resulting from multidisciplinary collaborations and 40 percent appearing in top-ranked journals. ■

www.bsse.ethz.ch
www.systemsx.ch

RESEARCH FUNDING

75 years of the Research Commission

On 12 December 1942, ETH Zurich made a decision that still shapes its research culture today: for 75 years, the ETH Zurich Research Commission has promoted scientific talent and supported original projects that show great innovation potential.

The ETH Zurich Research Commission supports original project ideas: setting up an experiment in the wind tunnel at the Institute of Aerodynamics in 1955.

Mid-way through the Second World War, the Schulrat – the university's governing body at the time – decided to form a Commission for Scientific Research at ETH. Ever since, ETH Zurich has provided research funding for bold, individual projects from all disciplines, ranging from basic research to the development of methods and applications.

The ETH Zurich Research Commission aims to support projects that open up new areas of research and may have a major scientific impact, increasingly focusing on those that utilise synergies between working groups. The broad-based Commission assesses projects based solely on scientific excellence, originality and innovation potential. Political criteria, subject matter or affiliation to a department of ETH play no part in the selection. "This allows the Research Commission to provide ETH start-up financing for original research as efficiently as possible," says its President, Uwe Sauer. "The ETH Research Commission is part of ETH Zurich's DNA," says Detlef Günther, ETH Vice President for Research and Corporate Relations, to whom the Commission reports.

The second focus area involves support for researchers at the beginning of their academic careers. Over the last 20 years, the Research Commission has awarded some 1,100 scholarships on behalf of the Swiss National Science Foundation for postdoctoral studies abroad. A good many of the recipients have gone on to work at ETH. Conversely, the Commission selects ambitious talents from all over the world for postdoctoral studies at ETH under the ETH Fellows programme. ■

www.ethz.ch/research-promotion

SWISS DATA SCIENCE CENTER

Swiss Data Science Center opens

Founded by ETH Zurich and EPFL, the Swiss Data Science Center (SDSC) opened in February. Its mission is to promote innovations in the realm of IT and data science and to provide an infrastructure for fostering multidisciplinary research and open science. It will employ 30 to 40 data and computer scientists and other experts at locations in Zurich and Lausanne. Focal points include personalised medicine, environmental sciences and new manufacturing technologies. A platform for data analysis will form a bridge between researchers who produce data and those who develop new data analysis techniques and data systems. Data science is a strategic focus area of the ETH Domain for the period 2017–2020. ■

https://datascience.ch

ENERGY TRANSITION

More funds for energy research

On behalf of the federal government, the Swiss Competence Centers for Energy Research (SCCERs) look for solutions to the challenges presented by the energy transition. Eight such centres were created in 2014. Researchers from the ETH Domain, universities and universities of applied sciences are working closely together. The Commission for Technology and Innovation (CTI – now Innosuisse) has allocated funding of 120 million Swiss francs to the centres for the period of 2017 to 2020 (72 million francs from 2013 to 2016). ETH Zurich manages three SCCERs: the Supply of Electricity SCCER carries out research on technical innovations in the areas of geo-energy and hydropower and on the optimum control and connection of water and electricity supplies. In the Efficiency of Industrial Processes SCCER, experts develop strategies to improve energy efficiency in industry, while the Efficient Technologies and Systems for Mobility SCCER seeks to develop knowledge and technologies for a sustainable mobility system. ■

www.ethz.ch/initiatives

CELL SCALES

How much does life weigh?

Cells are the building blocks of life and researchers have already unlocked many of their secrets, but it has so far been impossible to measure the weight of individual living cells in real time. Now, scientists led by ETH Professor Daniel J. Müller, working with colleagues from the University of Basel and University College London, have developed a new type of cell scale. The cell hangs on the underside of a microscopically small cantilever which is made to oscillate slightly. A laser measures the oscillations, first without and then with the cell. The cell's mass can then be calculated from the difference between the two measurements. It is possible to monitor, for example, how the cell's weight changes during cell division, or what happens when it is infected by a virus. The scale has been patented and has every prospect of being developed into a commercial product. The Swiss company Nanosurf is currently working on this. ■

www.ethz.ch/cell-scale

RENEWABLE ENERGY

Greater cooperation for more wind energy

Wind farms are currently distributed unevenly across Europe. Most of them are installed in countries bordering the North Sea, hence they are exposed to similar weather conditions. If European countries cooperated better in the field of wind energy, wind power output would fluctuate less. This is the conclusion reached by a group of energy and climate researchers at ETH Zurich and Imperial College London. In regions where wind power is hardly used at present, such as the Balkans, Greece, the western Mediterranean, and northern Scandinavia, there is enormous potential to develop additional capacity. In carrying out the study, the researchers were the first to combine large-scale weather data from the last 30 years with wind and solar electricity production data, using a simulation platform developed at ETH. ■

www.ethz.ch/wind-coordination

DONATIONS

New research in the micro range

Three donations have led to a new research project to gain a better understanding of marine microorganisms, the creation of an assistant professorship for microbiome research and the development of the Centre for Single-Atom Electronics and Photonics.

Supporting new research projects: a lecture theatre has been renamed in recognition of the support provided by the Helmut Horten Foundation.

As part of the Theory of Microbial Ecosystems (THE-ME) project, researchers from ETH Zurich and the Massachusetts Institute of Technology (MIT) are to research the ecosystems of marine microorganisms over the next five years. Invisible microbes account for the majority of all organisms. They generate biomass, produce and consume greenhouse gases and form the basis of the marine food chain. Despite microbial communities' significance for humans and the environment, they remain poorly researched. The New York-based Simons Foundation is supporting the project with funding of 15 million US dollars. The ETH professors involved in the project are: Roman Stocker, Professor of Groundwater and Hydromechanics; Sebastian Bonhoeffer, Professor of Theoretical Biology; and Martin Ackermann, Professor of Molecular Microbial Ecology.

ETH has invested a donation of 6 million Swiss francs from the Helmut Horten Foundation in two professorships in the field of biomedicine. One is a professorship of medical immunology, to which Federica Sallusto has been appointed. A human immunologist, she will assemble a new team in Zurich while continuing her work in Bellinzona at the Institute for Research in Biomedicine, Università della Svizzera Italiana. The Helmut Horten Foundation is also funding a new assistant professorship for microbiome research, which has been filled by Shinichi Sunagawa. Sunagawa researches microbial communities, focusing on marine ecosystems and the gastrointestinal tract of animals and humans, combining experimental and bioinformatic approaches.

The Werner Siemens Foundation has donated 12 million Swiss francs to establish a Centre for Single-Atom Electronics and Photonics. ETH and the Karlsruhe Institute of Technology (KIT) are establishing the centre together, to develop new types of integrated circuits for communications networks. The components operate at the level of individual atoms, making the circuits 100 to 1,000 times smaller and more energy-efficient than existing ones. ■

https://www.ethz-foundation.ch/en/

MOBILE HEALTH SYSTEMS LAB

An app that saves children's lives

Almost two million children worldwide die of pneumonia every year, often because the illness is not detected early enough. Walter Karlen, Assistant Professor at ETH and Head of its Mobile Health Systems Lab, is using mobile health technology to improve this tragic situation. He has developed an app to diagnose pneumonia in children faster and more reliably. "Apps have enormous potential to improve healthcare in places lacking medical equipment and expertise," says Karlen.

In places with poor medical infrastructure, it is frequently difficult for nurses to distinguish pneumonia from ordinary bronchitis, so children are often taken to hospital only when their condition is critical. The app helps nurses to measure the children's breathing rate, an important diagnostic marker for identifying pneumonia. They simply tap the screen on their smartphone each time they see the child breathe. If there is any break in the pattern, the app counts it as an accidentally missed measurement point and has the user keep tapping until the app can determine a reliable average value. The results obtained on different days can be stored and compared later on.

Karlen's team launched the project together with the Swiss Tropical and Public Health Institute (Swiss TPH) and Universidad Peruana Cayetano Heredia in order to improve living conditions and healthcare for children in northern Peru. Last year a study was carried out with local staff trained during the project. They visited 300 families per week to ask parents about their children's health and measure their breathing rate. In future, the app should also help to measure oxygen saturation in the blood and other important indicators of pneumonia. ■

www.ethz.ch/mhsl-app

The app improves pneumonia diagnosis in remote villages.

URBAN PLANNING

Using social media to create 3D city models

Three-dimensional modelling of cities is time-consuming and expensive. Researchers from the Computer Vision Lab led by ETH Professor Luc Van Gool have developed a technology platform called VarCity to create 3D city models from image data alone. This is done using aerial photographs, panoramic images, photos on social networks, YouTube videos and images from webcams. The new technology makes city models more lifelike, because they include people and vehicles. VarCity is nevertheless compatible with data privacy, as pedestrian flows and vehicle traffic are shown as avatars.

During the five-year project of the European Research Council (ERC), the project participants founded several spin-off companies: Spectando offers virtual building inspections for the real estate market, while Casalva performs virtual damage analyses on buildings for insurance companies. Parquery uses the technology for a parking guidance system that works exclusively with cameras and does not require parking space sensors. ■

www.ethz.ch/varcity

Using machine-learning algorithms, the model can recognise image content such as façades and windows.

MACHINE LEARNING

Computers learn to program

Researchers are teaching computers how to write their own software. Martin Vechev, ETH Professor of Computer Science, is one of the founders of this new field of research. It has been made possible thanks to machine learning algorithms and huge public software databases containing billions of lines of program code. Vechev is developing assistance programs that work in a similar way to the autocomplete functions we use today for writing text messages on smartphones: a software developer writes the first hundred lines of code, which the assistance program then analyses and compares with code in the database. Based on the results, the computer then suggests how to continue the code. In the process it increasingly understands the programmer's objectives and how to improve its suggestions. "In ten years' time, the degree of automation will be advanced enough for computers to be able to write short programmes autonomously," says Vechev. ■

www.ethz.ch/automatic-programming

GEOLOGY

Analysing landslides in the Alps

ETH researchers are observing the Alps to gain a better understanding of the effects of melting glaciers and thawing permafrost. Using a unique dataset, they have demonstrated a direct connection between ice loss in the Aletsch glacier and the slippage of the Moosfluh slope.

The Moosfluh, a slope bordering the Aletsch glacier, has been moving for many years. The whole slope, measuring about a square kilometre, is moving downhill faster and faster. ETH researchers from the Chair of Geotechnical Engineering have conducted a study showing that the slope's instability is connected to the retreat of glacier ice and hence climate change. This was done using data collected with airborne and terrestrial laser scanners, radar and GPS measurements. The researchers also analysed satellite and historical data concerning the glacier's height and length, and topographical maps.

Geologists have long been aware that slopes move as a result of glacier shrinkage. However, they had always assumed that this was a slow process. The scientists were surprised by the rate of change observed in the Aletsch region. Rockfalls on the Moosfluh slope were increasing in frequency and volume: before 2005, geologists recorded only one single rockfall involving around 5,000 cubic metres of rock debris. By 2011, two rockfalls of similar size had occurred. In 2011 and 2012, seven rockfalls thundered down the valley. While only two occurred between 2012 and 2015, they were far more powerful, loosening 10 and 30 times more rock debris respectively. Then in 2016, 2.5 million cubic metres broke away in a single incident.

Rockfalls also occur on the Piz Cengalo mountain, therefore it has been monitored for quite a number of years. In 2011, some 1.5 million cubic metres of rock fell into the valley. Unlike the Moosfluh, it was probably caused by the rock structure and permafrost processes rather than a melting glacier. Since then, the northeast wall of Piz Cengalo has been monitored and researched by the Association of Alpine States (Arge Alp), with the involvement of ETH researchers and an ETH spin-off, to learn more about the causes of rockfalls and landslides in permafrost regions. Between 2012 and 2015, geologists measured the geometry of geological fissures without requiring direct contact with the rock. Using terrestrial radar measurements, laser scanning and automated photographs, they were able to reconstruct volume changes, rock movements and the likelihood of movement in the future. Last August, 3 million cubic metres of rock broke off Piz Cengalo. Mixed with water, it formed a mudslide that rolled down the Val Bondasca valley towards the village of Bondo. Eight people hiking in the mountains were tragically buried in the rubble. Thanks to safely constructed buildings, as well as monitoring and early warning systems, Bondo suffered relatively minor damage and the village's inhabitants were evacuated in good time. ■

www.ethz.ch/landslide

Ground-based radar and laser measurements monitor changes in the Moosfluh.

MICROBIOLOGY

A better understanding of how vaccinations work

Vaccinations are known to protect against pathogens such as bacteria and viruses. They stimulate the body to form protective antibodies and have been used successfully to combat intestinal infections. However, it was previously unclear how vaccine-induced IgA antibodies in the intestine protect against infections. A group of researchers led by ETH senior scientist Emma Slack have used the example of salmonella-based diarrhoea to show that these antibodies work differently than was previously thought.

Pathogens formed into chains

The researchers have shown that the antibodies "enchain" pathogens in the intestine. As the bacteria multiply, the antibodies attach themselves to new bacteria. Although the bacteria clumped together in this way can continue to multiply, all their offspring remain trapped in the clumps and cannot attack the intestinal wall. This accelerates excretion of the pathogen and prevents genetic exchange between bacteria of different families. The advantage of clump formation is that the bacteria are not killed off, which could lead to a violent immune response. The antibodies simply prevent the microbes from interacting with the host, with each other or with close relatives. ETH Zurich awarded Slack the Latsis Prize in 2017 for her research in the field of bacterial infections. ■

www.ethz.ch/diarrhoea-pathogens

BIOTECHNOLOGY

Micronutrient rice prevents malnutrition

ETH researchers have developed a new rice variety that has increased levels of the micronutrients iron and zinc in the grains, while also producing beta-carotene, which is a precursor of vitamin A.

Almost half the world's population eats mainly rice to meet their daily calorie requirement. A meal of rice stops hunger, but contains few or none of the essential trace elements. Particularly in large parts of Asia and Africa, people suffer from malnutrition because they do not get enough iron, zinc or vitamin A to stay healthy. Among other things, this leads to anaemia, delayed brain development and increased maternal and infant mortality.

Some years ago, researchers led by ETH Professor Emeritus Ingo Potrykus developed a new rice variety that became known as Golden Rice. This was one of the first genetically modified rice varieties capable of producing beta-carotene, the precursor of vitamin A, in the endosperm of the rice grain. Since then, Golden Rice has been improved and is now cultivated in several countries as part of research programmes, mainly in Southeast Asia. Until now, the new rice varieties have only been able to provide one lacking trace element. Last year, a group led by Navreet Bhullar, senior scientist in the Laboratory of Plant Biotechnology at ETH Zurich, succeeded in genetically modifying rice plants so that their grains contain not only more beta-carotene but also sufficient levels of iron and zinc. "Our results demonstrate that it is possible to combine several essential micronutrients in a single rice plant for healthy nutrition," explains Bhullar. Selected lines will now be tested under controlled conditions in the open field, to find out whether the desired properties are retained. ■

www.ethz.ch/multi-nutrient-rice

Several important micronutrients can be combined in a single rice plant for healthy nutrition.

MANUFACTURING PROCESSES

4D printing of objects that change over time

A small number of researchers are currently developing 3D printing to include another dimension, namely time. So-called 4D printing creates moveable and shape-variable objects such as flat components that can be turned into three-dimensional objects at a later point, or objects that can change their shape depending on external influences.

Kristina Shea, Professor of Engineering Design and Computing at ETH Zurich, has developed a new design concept allowing the production of predictable load-bearing structures. The objects mainly consist of a rigid polymer and an elastic polymer for the parts that have to be moveable. Using a multi-material 3D printer, such parts can be manufactured in a single step. 4D objects can be used in aerospace in order to transport structures into space in a compressed state. Potential future applications include ventilation systems and medical devices such as stents, implantable devices to keep blood vessels open. ■

www.ethz.ch/4d-printing

An object is printed flat and later converted into two further stable shapes.

MEDICAL DIAGNOSTICS

Chip could revolutionise diagnostics

ETH Zurich and the pharmaceutical company Roche have developed a totally new diagnostic method for analysing molecules using a chip.

Viral illnesses, metabolic disorders and autoimmune diseases can be diagnosed by detecting them in blood or urine. However, such tests require specialist laboratories and often take several hours. Scientists from ETH Zurich and Roche have jointly developed a new analytical method using a chip with a specially coated surface. It is made up of tiny dots with a specific striped pattern called a mologram (molecular hologram). The molecules to be identified bind to the stripes but not to the interstices between the stripes. Laser light directed along the chip's surface is bent due to the special arrangement of molecules in the pattern. A point of light becomes visible below the chip. When samples without the molecules in question are placed on the chip, the light is not bent and no point of light is visible.

In the more distant future, patients may even be able to use the technology at home.

A key advantage of this method, known as focal molography, is that the signal (the point of light) only occurs because of the molecules that bind specifically to the mologram. Other molecules do not generate a signal. The technique is therefore quicker and simpler than previous methods, in which other molecules have to be washed away. This makes it ideal for measuring proteins in blood or other bodily fluids. "We expect this technology to enable more laboratory tests to be performed in doctors' surgeries rather than in a specialist laboratory," says Janos Vörös, Professor of Bioelectronics at ETH Zurich. "And in the more distant future, patients may even be able to use the technology at home." ■

www.ethz.ch/molecule-hologram

DIGITAL FABRICATION

Designed by algorithms, built by robots

In the NEST research building in Dübendorf, a group of ETH professors are building two residential units, largely designed, planned and created with digital processes.

The future of building is taking shape in the NEST research building for construction innovation run by Empa and Eawag in Dübendorf. Here, architects, robotics engineers, material scientists, structural engineers and sustainability experts from ETH Zurich are working with industry partners to transfer digital construction technologies from the laboratory into practice for the first time.

The work is based on two residential modules: in the DFAB HOUSE, individual components have been produced directly from digital design data, using two-metre high construction robots able to move autonomously on caterpillar tracks – even in a constantly changing environment. With a wire cutter and a welding head, the robot fabricates a steel wire mesh which serves both as formwork and as reinforcement for a load-bearing concrete wall. This does away with the costs and wear and tear involved in formwork construction. Other technologies employed in producing the residential module include an automated robotic slip-forming process for producing weight-optimised, bespoke concrete columns, a digitally designed and fabricated two-storey wooden structure assembled by two robots, and weight-optimised concrete ceiling slabs cast with formwork from a 3D printer.

The digital toolbox also opens up new design possibilities, as the second residential module HiLo illustrates: for the two-storey energy-plus building, the group led by ETH Professor Philippe Block constructed a doubly curved concrete shell. With the help of algorithms, the researchers designed the roof shape so that it offers maximum stability despite minimal use of materials. The 20-tonne concrete shell is between 3 and 12cm thick and self-supporting. In the construction process, a reusable mesh of steel cables was stretched in a large wooden frame and covered with a fabric which serves as formwork for the sprayed concrete. Engineers from the Automatic Control Laboratory used cameras, sensors and simulations to determine how forces are distributed across hundreds of cables and connecting pieces in order to ensure that the superimposed, wet concrete later assumes the precise design shape. ■

www.ethz.ch/dfab-house
www.ethz.ch/concrete-roof

The curved steel wire mesh produced by the In situ Fabricator robot serves both as formwork and as reinforcement for a concrete wall.

Method in their movement: if upward swimming plankton sense turbulence, the population splits into two groups.

ENVIRONMENTAL SCIENCES

Tracking algae behaviour

Plankton form the basis of the entire oceanic food chain. Researchers want to gain a better understanding of plankton behaviour, because turbulence in the oceans caused by progressive climate change varies from region to region. A group led by Roman Stocker, Professor at the ETH Zurich Institute of Environmental Engineering, examined the migratory behaviour of phytoplankton algae in the laboratory. By day, the algae use their flagella to swim towards the sunlit ocean surface to carry out photosynthesis. At night, they make their way to depths of 10–20 metres, where the nutrient supply is greater and they are safer from predators.

In their experiment, the researchers investigated what happens when a rising algae population encounters turbulence. They found that the algae split into two equally sized groups, of which one continues to make for the surface, while the other swims in the opposite direction. The researchers argue that this behaviour offers an evolutionary advantage. In the event of dangerous turbulence, in the worst case only half the algae will be lost rather than the entire population. ■

www.ethz.ch/plankton-behaviour

ZURICH HEART

Silicone heart from a 3D printer

Around 26 million people worldwide suffer from heart failure and would benefit from a heart transplant, but donor hearts are scarce. Artificial hearts and support systems help to bridge the waiting time until a patient receives a donor heart or their own heart recovers.

Like a real human heart

Researchers from teams led by ETH Professors Wendelin Stark and Mirko Meboldt have developed a soft silicone heart which closely mimics the real thing. Produced using a 3D printer, like a real human heart it has a right and left ventricle, though they are separated not by a septum but by an additional chamber. This chamber is inflated and deflated by pressurised air and is used to pump fluid from the blood chambers, imitating the muscle contraction of the human heart.

It currently lasts for around 3,000 beats, which corresponds to a lifetime of half to three quarters of an hour. The tensile strength of the material and the performance need to be significantly improved, say the researchers. The research was conducted as part of the Zurich Heart project of the University Medicine Zurich research network, bringing together scientists from 20 research groups, a range of disciplines and institutions to develop a fully implantable artificial heart. ■

www.ethz.ch/artificial-heart

QUANTUM PHYSICS

Experiment to demonstrate supersolidity

Remarkable phenomena sometimes occur when matter is cooled to near absolute zero. These include supersolidity, where crystalline structures and frictionless flow occur together.

A group of researchers led by Tilman Esslinger, Professor of Quantum Optics at the Institute for Quantum Electronics, and Tobias Donner, senior scientist at the same institute, have for the first time created such a supersolid state and proved it by experiment. In a vacuum chamber, the researchers cooled a small amount of rubidium gas to a temperature of a few billionths of a kelvin above absolute zero. As a result, the atoms condensed into what is known as a Bose–Einstein condensate, which behaves like a superfluid. The physicists illuminated the condensate with laser light, so that its atoms arranged themselves into a regular structure but the condensate still retained its superfluid properties.

The experiment was a practical demonstration of a theoretical concept proposed by scientists, including British physicist David Thouless, in 1969. ■

www.ethz.ch/supersolidity

Even during his Master's course, ETH postdoc **Lorenz Meier** had already started working on software that now looks set to become the gold standard for drone flight control. The trick is to use inexpensive cameras and computer chips that allow drones to fly around obstacles and navigate their own ideal course autonomously. Companies like Intel, Qualcomm, Sony and GoPro are already using the PX4 software. But the invention was not Meier's brainchild alone – many people collaborated on it worldwide. For Meier, the use of open-source code, allowing other programmers to refine and customise the software, is an important principle. The 32-year-old Swiss and co-founder of an ETH spin-off is a Pioneer Fellow and received funding from the ETH Excellence Scholarship & Opportunity Programme (ESOP).

Industry and society

One of ETH Zurich's major contributions to the Swiss economy is the results of its research, which consistently produce practical applications. These benefits include not only products and services created through industrial partnerships, but also the technologies that ETH spin-off companies develop and commercialise based on research findings. To give just one example: over the past 20 years, the four founders of the ETH spin-off u-blox have built up a global provider of communications technology employing around 1,000 people. Against this backdrop, it is particularly encouraging to report that a total of 25 new ETH spin-offs were established over the past year.

The annual Industry Day showed just how important ETH research is for Switzerland's economy. Around 600 business guests received an overview of current research projects that could have potential for industrial applications.

A whole series of public events were devoted to the theme of digitalisation. Scientifica, Treffpunkt Science City, the Cyber Risks Summit, the Digital Festival Zurich and the nationwide Digitaltag were ideal platforms for researchers to discuss the challenges and opportunities of digitalisation with representatives from political and business circles, as well as the wider community.

ETH SPIN-OFF U-BLOX CELEBRATES 20 YEARS

Innovations for the internet of things

From an ETH spin-off to a global technology leader: for the past 20 years, u-blox has been supplying industry with wireless communications technology for vehicles, mobile phones and, increasingly, the internet of things.

It all started back in the mid-1990s with the research group led by ETH Professor of Electronics Gerhard Tröster, who, together with his doctoral students Daniel Ammann, Andreas Thiel and Jean-Pierre Wyss, developed the world's smallest receiver for global positioning systems (GPS). In 1997 they founded u-blox and a year later presented their first commercial GPS product, which was used on heavy goods vehicles to implement Switzerland's "performance-related heavy vehicle fee".

In the year 2000, u-blox won an order from the Finnish manufacturer Benefon to supply thousands of GPS receivers for the world's first GPS-enabled mobile phones. After Benefon ran into financial difficulties, u-blox was left with large quantities of dedicated chips which were not paid for – and, even worse, were unsellable – pushing the firm to the brink of bankruptcy in 2002. But the founders didn't give up: they appointed Thomas Seiler, an ETH Zurich mechanical engineer and MBA graduate with proven industry experience, as CEO. At roughly the same time, GPS chips were becoming a standard feature in vehicles and mobile phones. The company produced a million GPS chips in the period up to 2004, and three years later was a global leader in the GPS market. In 2007, u-blox's IPO on the Swiss stock exchange raised capital of 65 million Swiss francs. Between 2009 and 2015, u-blox acquired 12 smaller companies, entered the wireless communication market and achieved continuous earnings growth. It also started to manufacture more and more products for the internet of things.

From its base in Thalwil along Lake Zurich, u-blox today employs over 1,000 people in 25 countries. "Our success has always been heavily based on close collaboration between the company's original founders and our management team," Tröster says, "coupled with the right technology at the right time, and the readiness to take on new market challenges." ■

www.u-blox.com

SPIN-OFF REVIEW 2017

Another 25 spin-offs founded

There were 25 spin-offs founded at ETH Zurich in 2017, equalling the record numbers of previous years. Many of the young companies are active in the area of digital technologies and data science.

ETH Zurich can look back on another successful year of spin-offs, making three record years in a row: in 2017, ETH researchers started another 25 new companies. Eight of these were created through ETH's internal Pioneer Fellowship programme, which helps students put their ideas into practice and set up businesses. For Detlef Günther, Vice President for Research and Corporate Relations, this high number shows that it pays off to nurture young scientists from an early stage. Female researchers co-founded seven of the new ETH spin-offs.

Broader digitalisation, closer networking

The topical focus of the ETH spin-offs reflects the enormous diversity of research at ETH Zurich. The trend towards digitalisation plays a role here as well: many of the spin-offs founded in 2017 are active in the fields of digital technology and data science. The app developed by Pathmate Technologies, for example, gathers clinical data that allow patients to measure the efficacy of their own medical treatment, while the DataHow spin-off employs machine learning in a way that optimises the industrial processes of pharmaceutical companies.

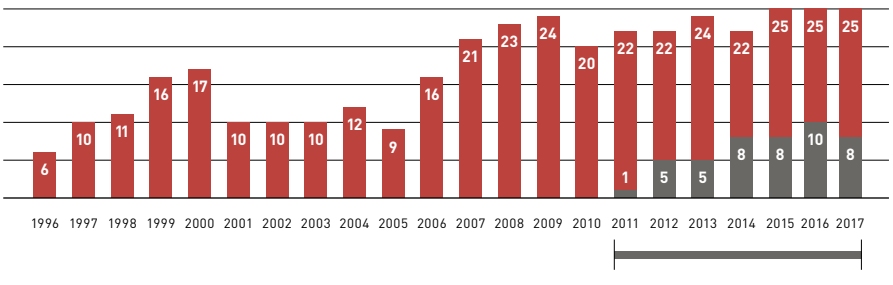
ETH spin-offs have now developed into a lively scene that is not only experiencing a rise in numbers, but is also more closely networked. At the same time, more and more established spin-offs are collaborating with young researchers from the Pioneer Fellowship programme. The Climeworks spin-off founded in 2009, for example, has joined forces with the young company Sunredox, which was only set up in 2017 and is working on the development of clean liquid fuels.

The success of ETH spin-offs can also be measured by the level of investment in these companies, which exceeded 120 million Swiss francs in 2017. GetYourGuide alone attracted more 75 million francs: the internet company has established itself as market leader for guides and travel activities at more than 7,000 destinations and now plans to double the number of staff at its Zurich headquarters. ■

www.ethz.ch/spin-offs-en

ETH spin-offs have now developed into a lively scene that is not only experiencing a rise in numbers, but is also more closely networked.

ETH Zurich's 380 start-ups over the period 1996–2017



■ Pioneer Fellows have founded a total of 45 spin-offs since 2011

ETH Vice President Detlef Günther (2nd from right) with the winners of the 2017 Spark Award: Michael Meyer, Sabine Werner and Luigi Maddaluno (left to right).

SPARK AWARD

Groundbreaking approach to combating viral diseases

The Spark Award 2017 went to the research group led by Sabine Werner, Professor of Cell Biology at ETH Zurich. The jury, made up of ETH specialists and external scientific and economic experts, singled out the work of Werner's team from among the five finalists because their research could represent a decisive step forward for medicine, and thus for countless patients. If the findings are verified, they could lead to the development of better treatments for viral diseases such as herpes.

Many drugs currently only work against individual virus groups and often their efficacy is limited. The award-winning research team has identified a biological mechanism that makes it possible to treat infections caused by many different viruses. Rather than attacking the virus directly, the mechanism mobilises the body's immune system. It therefore has fewer side effects and in future could also be used to tackle epidemics. The Spark Award has been running since 2012, with the jury picking ETH Zurich's most worthy patent application over the past year. ■

www.ethz.ch/sparkaward

ENERGY SCIENCE CENTER SYMPOSIUM

Energy strategies on the test bench

In April 2017 a symposium with an innovative structure, entitled The Global Energy Challenge – A Corporate View, showed how fruitful collaboration between industry and science can be, particularly when it comes to new developments in the field of energy.

Representatives of multinational companies, including ABB, Shell and Swiss Re, presented their energy strategies and visions, which ETH researchers then discussed from a scientific perspective. "Direct comparison of corporate strategies highlights differences, and discussion with ETH professors is important in order to probe companies' plans," says Christian Schaffner, Director of the ETH Energy Science Center and organiser of the event. "We are convinced that industry will play an important role when it comes to mastering global challenges in the energy supply." The symposium is intended to complement established ETH events organised by and for scientists. ■

www.ethz.ch/the-global-energy-challenge

EYE SURGERY

The robotic eye surgeon

In Switzerland, macular degeneration is the most common cause of severe visual impairment in elderly people. One in five people over age 80 is affected. The disease cannot be cured, but it can be treated with medication. To do so, a drug must be injected directly into the patient's eye every four to six weeks. Some 100,000 injections of this type are performed every year in Switzerland. "Our robot will be the first that can be used for injections," says Franziska Ullrich, ETH mechanical engineer and CEO of the ETH spin-off Ophthorobotics.

The mobile device has been developed by ETH researchers in the Multi-Scale Robotic Lab together with doctors from Triemli Hospital in Zurich. It is placed above the reclining patient's head and uses two cameras to form a 3D image of the eye to be injected. It then calculates the correct insertion point and automatically positions the injection needle. The doctor is then able to monitor everything in real time and press a button to start the injection. "The robot makes the intervention safer and more precise," Ullrich explains. The robot uses sensors to check whether the patient moves their head just before the needle is inserted – in which case the procedure is stopped. Researchers are currently working on a device suitable for clinical use that has already attracted interest from several eye clinics. ■

www.ethz.ch/eye-robot

The robot's sensors can react much faster than a human doctor.

WORLD ECONOMIC FORUM 2017

Magic through technology

ETH Zurich presented its latest research findings in a public exhibition at the annual World Economic Forum (WEF) 2017. This also provided an opportunity to build contacts with global partners, as well as public authorities and business people from the canton of Graubünden.

There was plenty to try out at the ETH exhibition: an app developed by the university's Game Technology Center lets users play around with the shape and colours of paintings.

At the WEF 2017 summit, ETH President Lino Guzzella invited leaders from the canton of Graubünden to a breakfast meeting with a scientific flavour, and also welcomed many international guests at two evening receptions dedicated to robotics and gaming technology. The new research area of media technology – which ETH will be establishing along with Swiss media companies Tamedia, Ringier, NZZ and SRG – also featured prominently.

In addition to official appearances at closed events and WEF workshops, ETH also presented its latest research findings in a public exhibition entitled Magic Through Technology. "One of the reasons we've come to Davos is to explore and deepen opportunities for collaboration," Guzzella commented. Amongst other things, ETH researchers allowed visitors to explore the world of innovative digital games. They included a digital race where victory or defeat is decided by users controlling their own brainwaves, and a digital sketchbook that allows users to bring their own sketches to life as 3D images. ■

www.ethz.ch/eth-at-wef-2017

INDUSTRY DAY 2017

Showcasing ETH research

Around 600 guests from business and industry attended the university's Industry Day 2017, where they heard about the latest research findings and the launch of a dedicated newsletter: *ETH News for Industry.*

At Industry Day, an annual event organised by ETH Zurich, industry representatives are given an insight into the university's latest research projects that could potentially be developed into commercial applications. One example is sophisticated power supply networks, which increasingly contain intelligent network components, sensors and meters and can thus accumulate large amounts of data.

In lectures covering the fields of mobility and energy, construction and production, information and communication, as well as health, nutrition and the environment, ETH professors and spin-off companies had the chance to present their work. Also, one part of the exhibition was devoted to advancing the direct exchange of know-how between science and industry. "Many of today's complex problems can be solved at the interface between research and industry," commented Detlef Günther, ETH Vice President for Research and Corporate Relations.

ETH News for Industry

The event also saw the launch of a newsletter tailored to the specific needs of industry, so as to provide companies with regular insights into current research projects. Published every two months, *ETH News for Industry* contains articles and videos in English about new ETH projects. There is also a dedicated web portal where companies can find information about current research, potential partnerships, licences and forthcoming events. ■

www.ethz.ch/industry-day-2017
www.industrynews.ethz.ch

Many of today's complex problems can be solved at the interface between research and industry.

SWISS POLAR INSTITUTE

ETH involved in Antarctic circumnavigation

The Swiss Polar Institute's first major expedition came to an end in March 2017. In total, the three stages of the Antarctic's circumnavigation involved 159 researchers, including ETH climate scientist Heini Wernli.

Founded in 2016 by a consortium of universities including ETH Zurich, the Swiss Polar Institute (SPI) quickly launched an ambitious research project: the Antarctic Circumnavigation Expedition (ACE), the first scientific mission involving the complete circumnavigation of the Antarctic region. A total of 159 international scientists spent three months on board the Russian research vessel *Akademik Treshnikov* in the period up to March 2017. Their mission was to measure the effects of climate change and pollution levels in the Southern Ocean. In all, 22 interdisciplinary research projects were selected before the expedition began. One of them, led by Professor Heini Wernli from the ETH Institute for Atmospheric and Climate Science, explored the interaction between the ocean and the atmosphere so as to deepen our understanding of the global water cycle. During the expedition scientists took regular samples to measure water isotopes in atmospheric water vapour and local precipitation.

The mission of the interdisciplinary SPI is to study the Earth's poles and other extreme environments. The SPI is a collaboration between EPFL, the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL), ETH Zurich and the University of Bern, co-founded with the publishing company Éditions Paulsen. The functioning of the planet's poles plays a crucial role in maintaining climate balance. The research undertaken by the institute is meant to provide better information to the public about the challenges associated with the state of the poles and the global climate in general. ■

https://polar.epfl.ch/page-134197-en.html

VENTURE AWARD 2017

Two winning projects involving ETH scientists

Projects supported by ETH won stellar accolades at this year's Venture Awards for start-ups. The prize for the best business idea went to ETH Professor Orçun Göksel and Dr Sergio Sanabria of the Computer Vision Laboratory. Their start-up, Reflectus, offers a technology for diagnosing breast cancer that is more convenient, affordable and accurate than conventional mammography and could potentially give more women access to better cancer care. The prize for the best business plan went to Lumigbo (Lumendo). This start-up, in which ETH researchers are involved, has developed technology for simplified root canal treatment where dental implants are hardened directly in the body by means of a light source. In future, the technology could be adapted for use in many different applications. ■

www.venture.ch

ETH SPIN-OFF CLIMEWORKS

The first commercial CO_2 vacuum cleaner

A global first: the ETH spin-off Climeworks, founded in 2009, has inaugurated its first commercial facility for filtering carbon dioxide (CO_2) from the atmosphere. Every year, the 18 installed CO_2 collectors will remove around 900 tonnes of carbon dioxide from the ambient air. Mounted on the roof of a waste incineration plant, the collectors use the waste heat to separate CO_2 from the filters and feed it into a nearby greenhouse, where it acts as a fertiliser to speed up plant growth and boost crop yields by up to 20 percent. The innovative facility is the result of many years of research and the first step towards the commercialisation of direct air capture technology. This could make a vital contribution to the global battle against climate change and towards achieving the Paris accord 2-degree target. ■

www.climeworks.com

Filtering CO_2 from ambient air: Climeworks founders Christoph Gebald and Jan Wurzbacher (from left to right).

NEW MANDATE FOR ETH

Stronger presence in the Asia-Pacific region

ETH Zurich has been named the Leading House for the Swiss Science and Technology programme in the Asia-Pacific region. The mandate, awarded by the State Secretary for Education, Research, and Innovation Mauro Dell'Ambrogio, entrusts ETH Zurich with the management of a budget of 3.5 million Swiss francs over the period 2017–2020. The funding will support the efforts of universities throughout Switzerland to engage in bilateral science and technology partnerships in Asian countries. ETH has been the Leading House for China, Japan and South Korea since 2008, and the new mandate extends this responsibility to include the entire Asia-Pacific region apart from India. ■

www.ethz.ch/research-in-asia

ETH GLOBAL

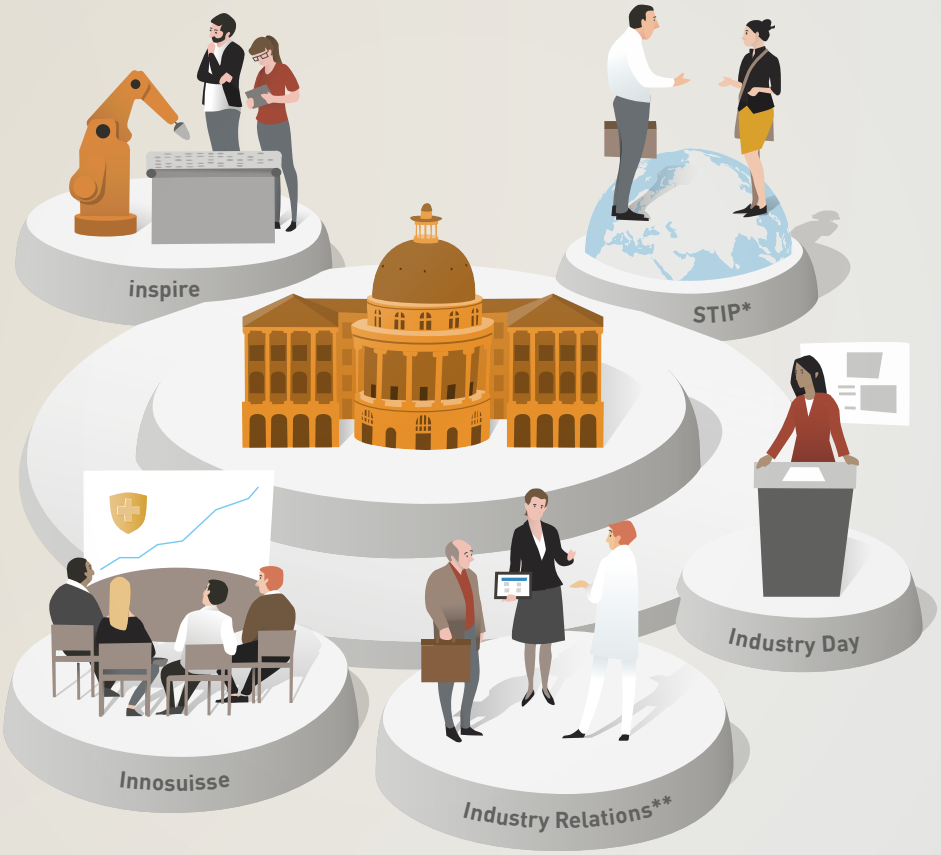
New: ETH Studio New York

In recent years, New York has become a very popular hub for technology companies and universities. The new ETH Studio New York intends to benefit from this dynamic trend. Its focus is information security, and during the pilot phase up to the end of 2018 it will gather in research projects put forward by universities, companies and start-ups based in Zurich and New York. Selected projects will be allocated to ETH students, whose task is to find solutions to the challenges of digitalisation. In addition to practical experience, students have the chance to develop other skills in the areas of design thinking, critical thinking, system understanding, teamwork and interdisciplinary cooperation. At the same time, the ETH Studio will build long-term alliances with New York institutions and raise the Swiss university's public profile on the US East Coast. ■

www.ethz.ch/studios

The new ETH Studio wants to benefit from the popularity of New York as a hub for technology and university research, and raise the university's public profile in the USA.

Connections and dialogue between SMEs and ETH Zurich



* Swiss Technology Impact Platform
** with an online portal for industry: www.industrynews.ethz.ch

SINGAPORE–ETH CENTRE

Expansion of ETH's Asian research hub

ETH Zurich has been present in Singapore since 2010, when it set up the Singapore–ETH Centre (SEC). Today, 200 people are conducting research into cities of the future and the resilience of infrastructure systems. In its second phase (2015 to 2020), the Future Cities Laboratory is focusing on generating knowledge and ideas for the planning, design and management of sustainable and liveable cities. The emphasis is on the rapidly urbanising regions of Southeast Asia, China and India. The second research programme, Future Resilient Systems, will also continue. It is dedicated to exploring how to make interconnected critical infrastructures more reliable and less susceptible to disruptions. Now the SEC plans to launch a third research programme, this time in the healthcare sector: Future Health Technologies. The SEC's contacts in Asia should benefit Swiss small and medium-sized businesses as well. The Swiss Technology Impact Platform (STIP) was set up in 2016 precisely for this purpose, organising the first local study tour for company representatives in 2017. ■

www.sec.ethz.ch

Main depot used as a collection and exhibition space, 1924–1969.

Adam and Eve, Albrecht Dürer, 1504.

150 YEARS OF THE GRAPHISCHE SAMMLUNG

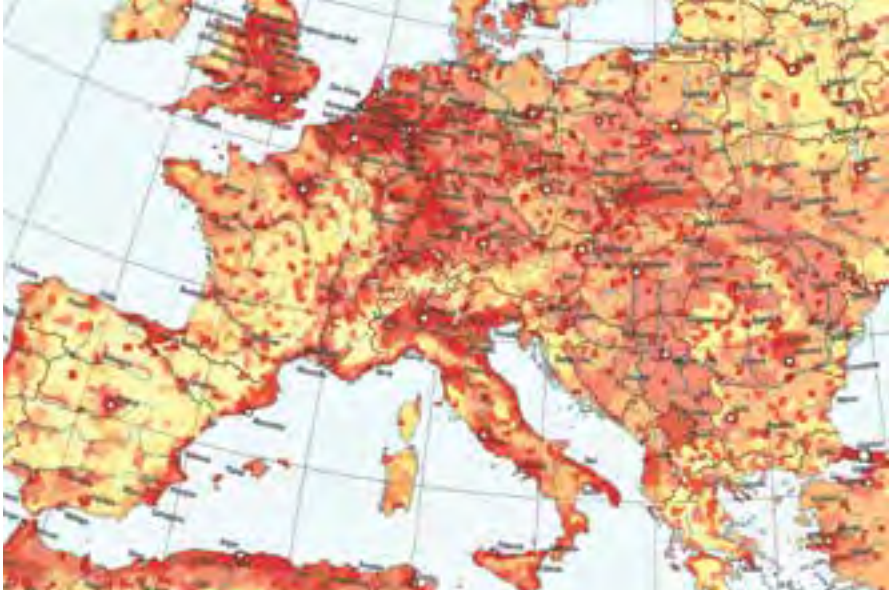
Old masters for a young public

ETH Zurich's collection of prints and drawings – the Graphische Sammlung der ETH Zürich – celebrated its 150th anniversary in 2017. The 160,000 works include pieces from a very diverse range of artists including Pablo Picasso, Rembrandt, Goya, Andy Warhol and Fischli/Weiss.

The Graphische Sammlung der ETH Zürich is one of the largest and most important collections of its kind in Switzerland, enjoying international acclaim. Since it was founded in 1867, it has grown far beyond the original scope of a university collection thanks to regular purchases and numerous gifts. In addition to the main focus on the old masters, it also includes sizeable groups of works comprising Swiss prints and drawings from the 19th to the 21st century. "The fact that ETH Zurich is the caretaker of cultural assets of international importance 150 years later is a huge privilege and a source of immense pride," commented Professor Ulrich Weidmann, Vice President for Human Resources and Infrastructure, to mark the occasion. Those in charge of the collection, which is part of the ETH Library, are using the anniversary to open up the works to a wider public and a younger audience. The first exhibition in February was therefore a co-production with the Helmhaus Zurich museum, followed in May by a joint project with the Institute for the History and Theory of Architecture (gta), which was also celebrating its 50th anniversary. The last exhibition of the year – co-curated by students from ETH Zurich and the University of Zurich – showcased young Swiss artists. ■

www.ethz.ch/150-years-gs

The current exhibition space of the collection.



Population density in Europe.

SWISS WORLD ATLAS

A new view of the world

Since 1910, the Swiss World Atlas has accompanied generations of secondary-school pupils through their geography lessons. ETH Professor Lorenz Hurni and his team at the Institute of Cartography and Geoinformation have now produced a new and completely revised edition. In the redesigned introduction to the atlas, the researchers provide some insight into their work and explain for the first time how they select and edit spatial data, turning it into vivid maps. This will help school students to learn how maps are created, and how to read and use them. The atlas also contains a whole range of newly designed maps, such as an overview of the economic power of urban centres around the world. There are also maps showing the world's key raw material mining regions and the intensity of agricultural use. The print version of the atlas is complemented by a website offering interactive programs and infographics. ■

www.ethz.ch/world-atlas

BOOK LAUNCH

Globi and the 3D chocolate printer

The 87th volume in the popular Globi series, *Globi and the Crazy Machine,* was officially launched at the university's *focus*-Terra Earth Science Research and Information Centre in March 2017. The new book is set at ETH Zurich. In the story, a professor invites Globi to her lab, which is home to the "crazy machine" of the book's title – crazy because it suddenly shrinks the two protagonists. Reduced to the size of a pea, Globi and the ETH professor experience amazing adventures in different ETH laboratories. "ETH would like to get as many children as possible into technology and science from an early age," says ETH Rector Sarah Springman, explaining why the university decided to collaborate with the Globi publishing house. The ETH project team worked closely with the illustrator Daniel Frick to develop an exciting story that would bring the fascinating world of ETH into children's bedrooms. Around 30 children were invited to the official launch, where they had the chance to see places and objects from the book in real life, including the robot dog StarlETH, the earthquake simulator and a 3D chocolate printer. ■

Globi at ETH: around 30 children were invited to attend the exclusive book launch.

www.ethz.ch/globi-at-eth

ETH would like to get as many children as possible into technology and science from an early age.

DATA SCIENCE

Data, digitalisation and data security

An increasingly digitalised world is producing data at an unprecedented rate. A series of events in 2017 focused on data science, one of ETH Zurich's strategic research areas.

The 2017 events kicked off with Scientifica, which attracted over 30,000 visitors to ETH and the University of Zurich. At the Zurich Science Days, visitors received first-hand information and the opportunity to put their questions directly to researchers. Presentations, workshops and short lectures explained how digitalisation is transforming not only areas such as robotics and climate science, but also linguistic and cultural studies. The ten spin-offs from ETH and the University of Zurich, attending Scientifica for the first time, showed how new scientific findings can be transformed into practical business ideas.

Treffpunkt Science City once again took place from March to April 2017: a free, easy-to-understand science programme with lectures, panel discussions, demonstrations and experiments for young and old. This year's theme was Working in the World 4.0, which was introduced by the industrial and organisational psychologist Theo Wehner. He explained that today only half as many people are needed to achieve the same productivity as 30 years ago. This raises the question: What are people doing with their free time, and what about those who cannot find work?

Top: During his visit to ETH, Switzerland's Defence Minister Guy Parmelin gave a public speech in which he emphasised the importance of establishing a specialist unit to defend against attacks from cyberspace. Bottom: On Digital Day, school pupils had the chance to attend a programming workshop.

More security in cyberspace

At June's Cyber Risks Summit, international experts discussed the latest approaches for effectively protecting society from the dangers of cyberspace. This event was organised by the Zurich Information Security & Privacy Center (ZISC), which ETH founded around 15 years ago to tackle information security issues. ZISC's cross-industry work is more relevant than ever, as ETH President Lino Guzzella emphasised in his opening address: "It's time for science, business and government to join forces in developing effective protection against the dangers of cyberspace." As a bridge to the panel discussion "Switzerland – the world's first internet-secure country?", Adrian Perrig, Head of ETH's Institute of Information Security, presented his new internet architecture SCION and discussed its practical relevance with guests from industry and commerce.

At last September's Digital Festival Zurich, ETH organised a special session entitled Security Technologies Enabling the Future: From Blockchains to IoT, where experts from the fields of science and industry provided insights into current trends and research in the field of information security.

Information security was also the main topic when Guy Parmelin, Switzerland's Defence Minister, visited ETH in October. In his speech, he stressed the importance of establishing a unit to defend against attacks from cyberspace. To achieve this, the Federal Council is counting on the support of ETH and, above all, of its graduates.

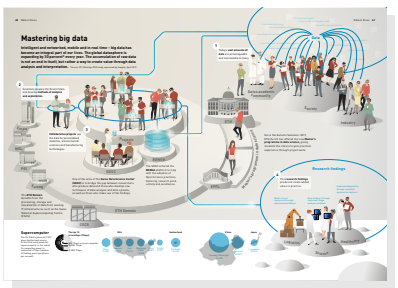
Finally, the first nationwide Digitaltag (Digital Day) took place in November, with exhibitors including ETH hosting over 80 free events for the public. They all had one common thread: data have become an integral part of our lives. ■

www.ethz.ch/scientifica-17
www.ethz.ch/treffpunkt-en
www.ethz.ch/cyber-risks-summit-2017
www.ethz.ch/digital-festival-2017
www.ethz.ch/guy-parmelin-visit
www.ethz.ch/digitalday-2017

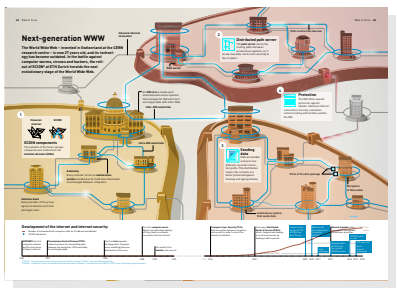
Data in focus

In our digital world, data is produced on an unprecedented scale. Securing and evaluating this data opens up new possibilities for fundamental research, enabling data science to gain new knowledge and help to develop solutions to the important issues of today.

Data science is at the interface of data management and engineering sciences, statistics, machine learning, algorithms, data optimisation and data visualisation. Its methods and knowledge are used, inter alia, in social and economic sciences, medicine and environmental science.



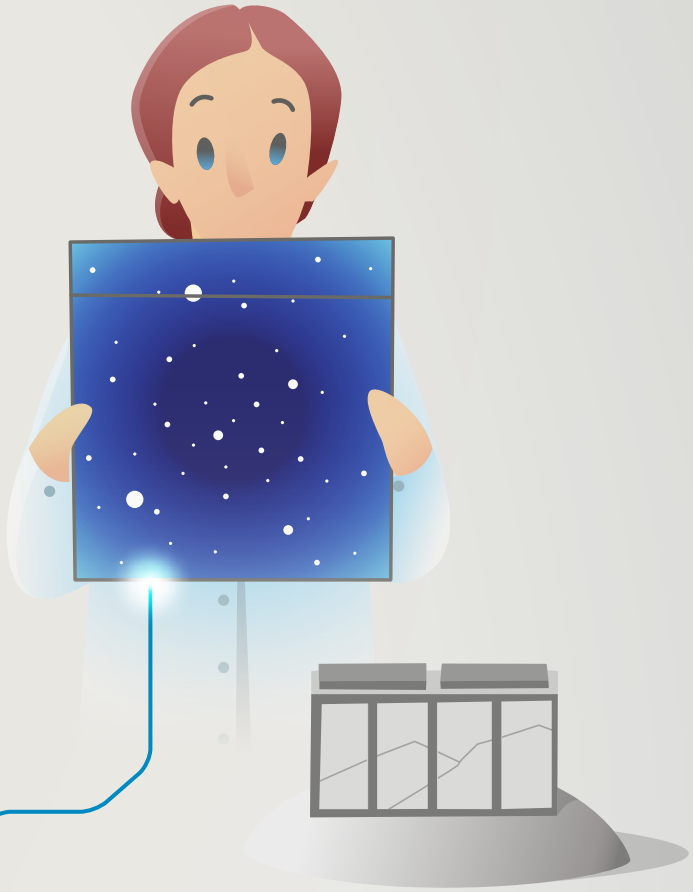
p. 40
Data science

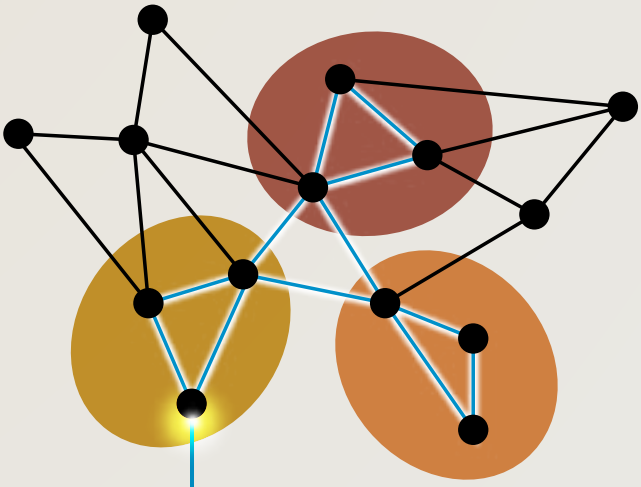


p. 42
Cyber-security

Researchers at ETH Zurich are developing new approaches to data science and machine learning. They are involved with other institutions at interdisciplinary research centres; ETH Zurich and EPFL jointly operate the Swiss Data Science Center in Zurich and Lausanne, which brings the expertise of data specialists together and offers an inter-disciplinary platform that enhances education and the transfer of knowledge. As part of this national initiative, for example, ETH Zurich trains Master's students in data science.

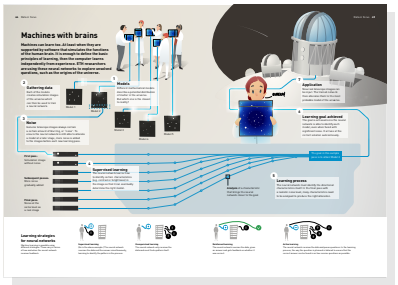
At the Max Planck ETH Center for Learning Systems, ETH Zurich and the Max Planck Society investigate the basic mechanisms of complex systems and develop approaches for learning systems that process data in new ways. At the Zurich Information Security and Privacy Center (ZISC), ETH researchers work with leading industry partners to develop new approaches to secure information systems and data exchange. ETH Zurich is setting up the Citizen Science competence centre with the University of Zurich to involve citizens in data science.



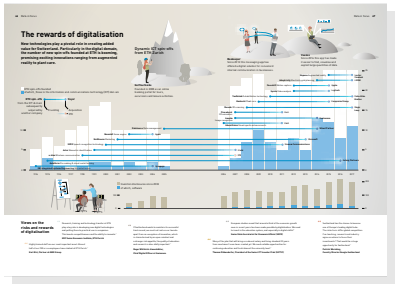


ETH Zurich is expanding its infrastructure in order to carry out data-intensive research. In 2017, it has set up LeonhardOpen and LeonhardMed; these two storage and computer clusters are capable of examining huge amounts of data for patterns and contexts.

Another special computing infrastructure is the supercomputer at the Swiss National Supercomputing Centre CSCS in Lugano, which is part of ETH Zurich. The CSCS is developing both its supercomputing infrastructure towards the exascale performance class and its user lab for simulation-based science. This means that questions that previously would have taken months to solve, if at all, can now be processed by the supercomputer in a few days.



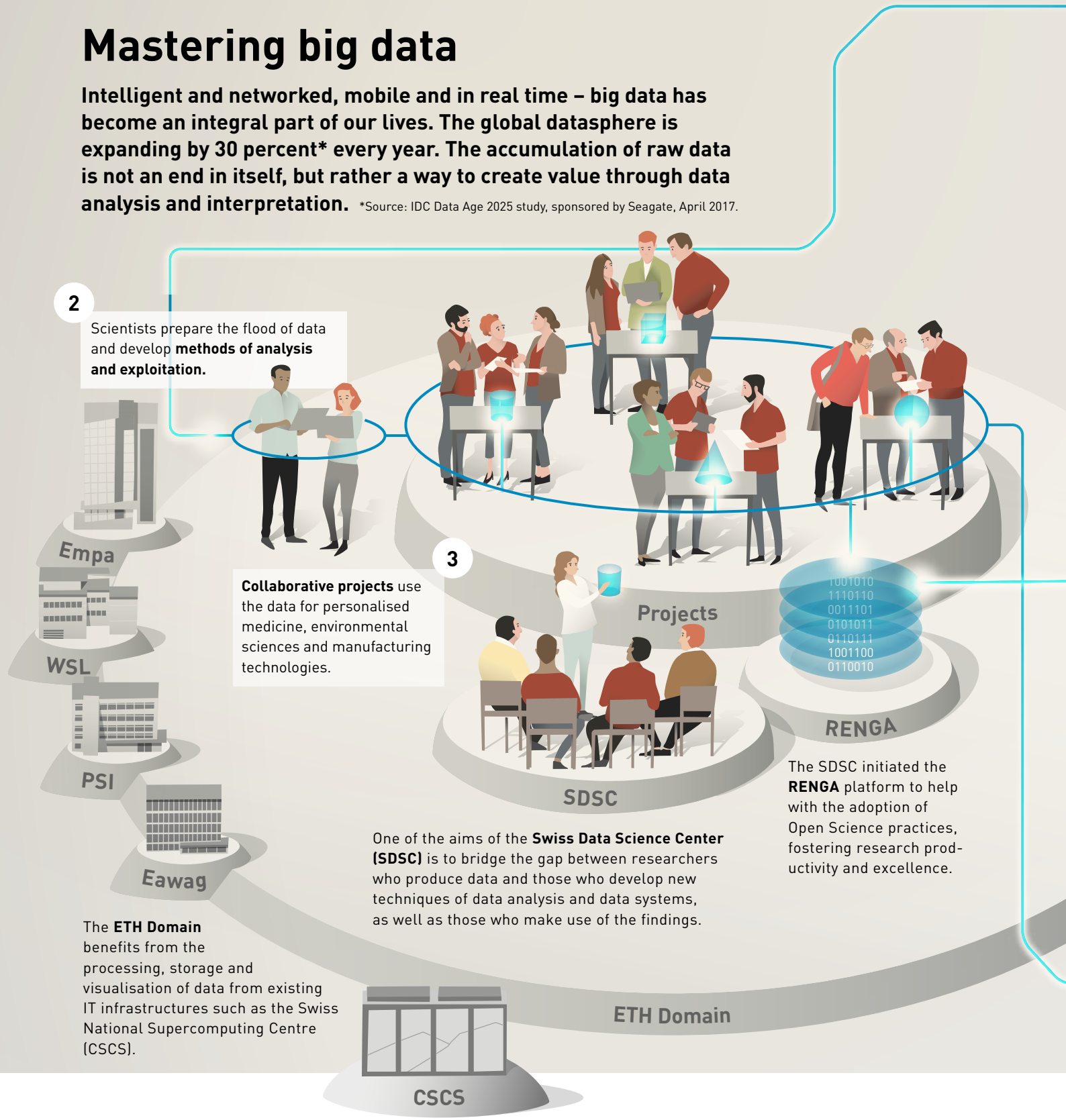
p. 44
Machine learning



p. 46
Transfer of knowledge and technology

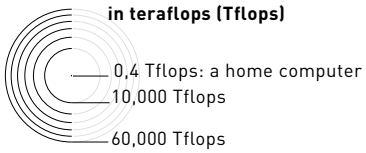
Mastering big data

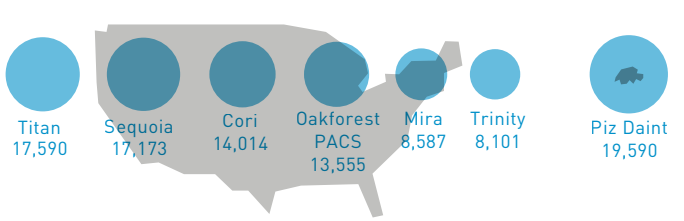
Intelligent and networked, mobile and in real time – big data has become an integral part of our lives. The global datasphere is expanding by 30 percent* every year. The accumulation of raw data is not an end in itself, but rather a way to create value through data analysis and interpretation. *Source: IDC Data Age 2025 study, sponsored by Seagate, April 2017.

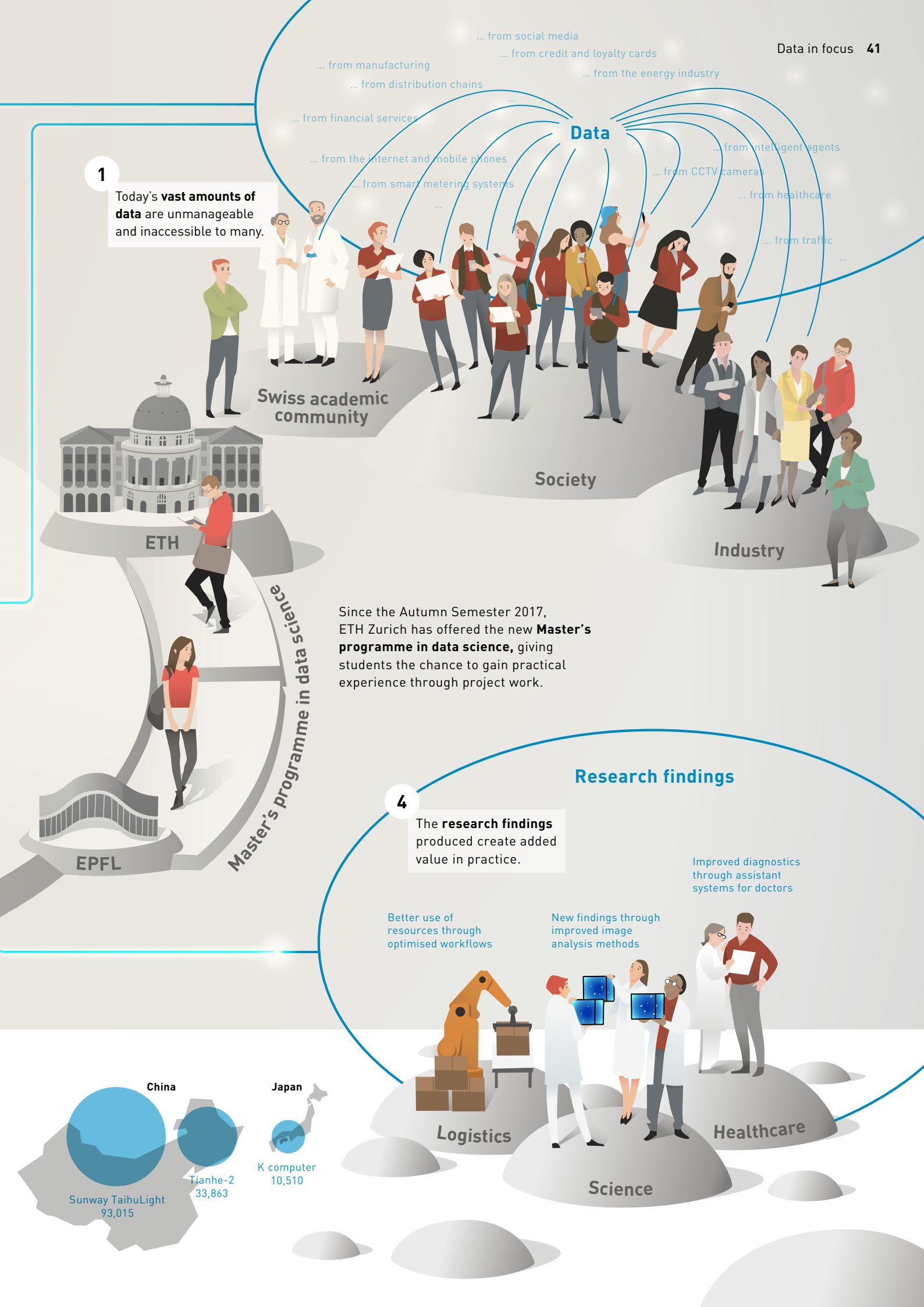


Supercomputer

The Piz Daint system at CSCS gives Switzerland access to the third most powerful supercomputer in the world. Its computing power is measured in flops (number of floating point operations per second).

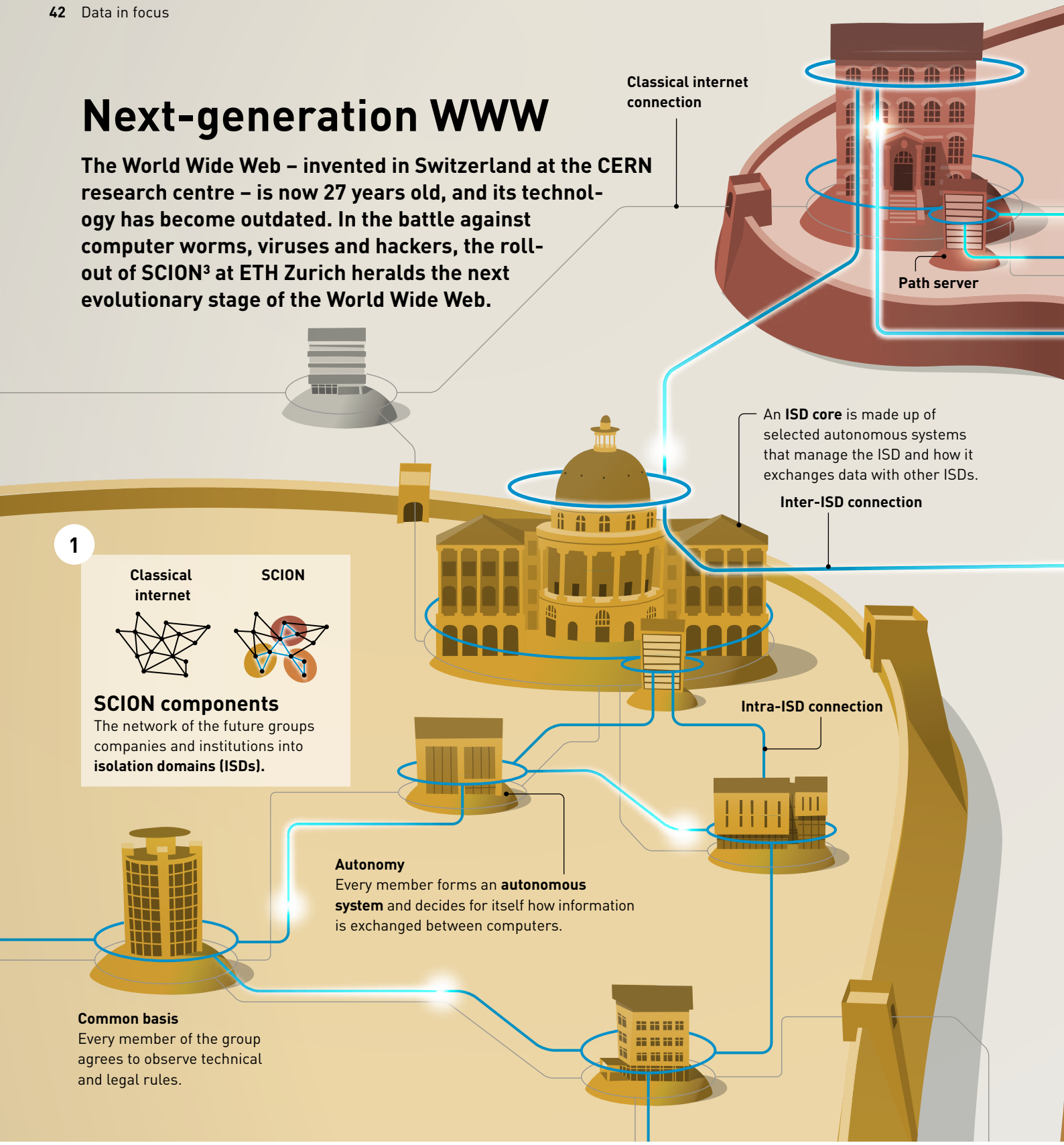





... from social media
... from credit and loyalty cards
... from manufacturing
... from the energy industry
... from distribution chains
...
... from financial services
Data
... from intelligent agents
... from the internet and mobile phones
... from CCTV cameras
... from smart metering systems
... from healthcare
...
... from traffic
...
1
Today's vast amounts of data are unmanageable and inaccessible to many.
Swiss academic community
Society
ETH
Industry
Master's programme in data science
EPFL
Since the Autumn Semester 2017, ETH Zurich has offered the new Master's programme in data science, giving students the chance to gain practical experience through project work.
Research findings
4
The research findings produced create added value in practice.
Improved diagnostics through assistant systems for doctors
Better use of resources through optimised workflows
New findings through improved image analysis methods
Logistics
Healthcare
Science
China
Sunway TaihuLight 93,015
Tianhe-2 33,863
Japan
K computer 10,510

Next-generation WWW

The World Wide Web – invented in Switzerland at the CERN research centre – is now 27 years old, and its technology has become outdated. In the battle against computer worms, viruses and hackers, the roll-out of SCION[3] at ETH Zurich heralds the next evolutionary stage of the World Wide Web.



Development of the internet and internet security:

Number of networked host computers with an IP address (worldwide)

SCION milestones

ARPANET: the first computer network and the forerunner of today's internet. — 1969

Transmission Control Protocol (TCP): network protocol for transmitting data between two end points. Still used today for exchanging data. — 1973

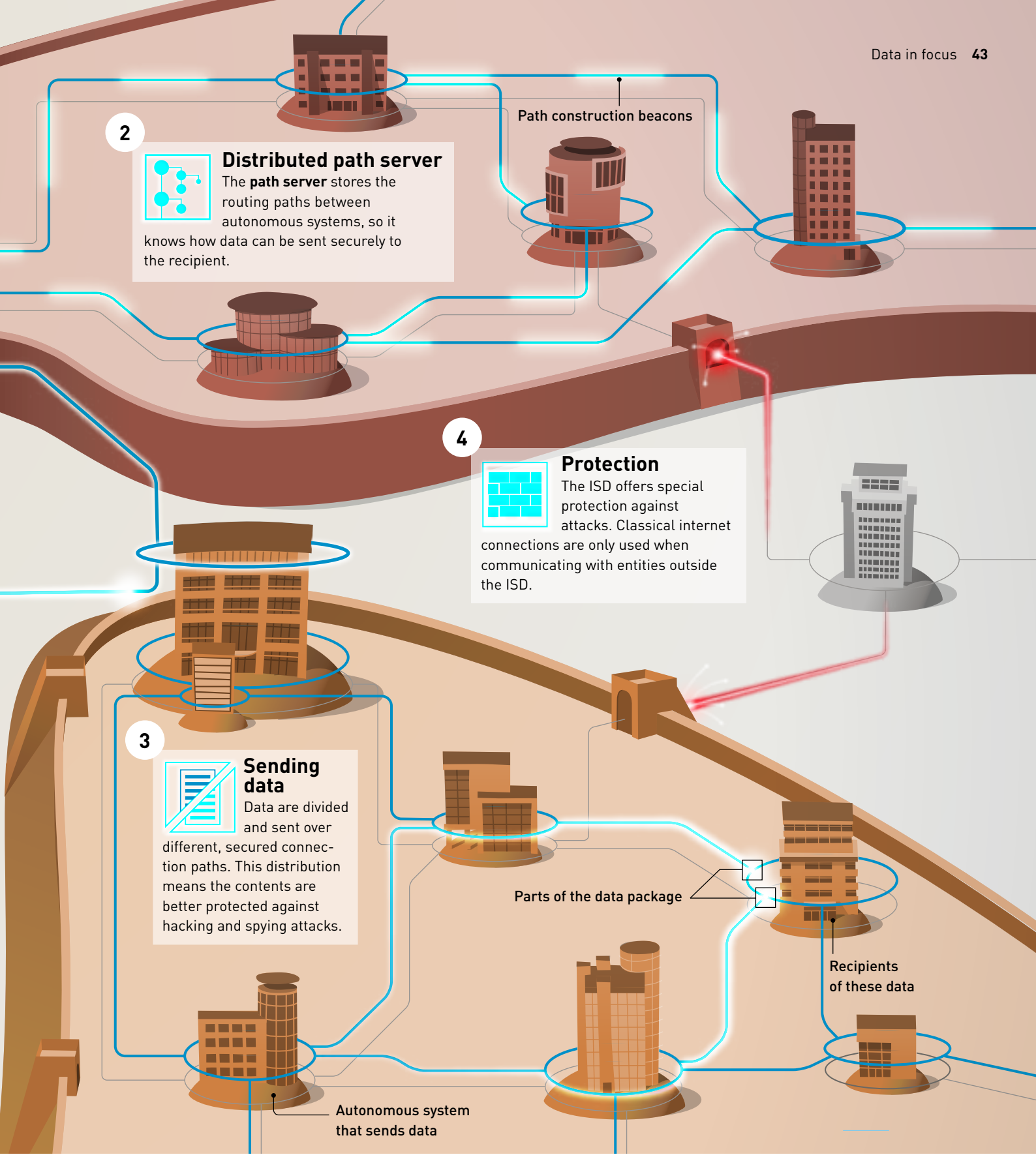
The first **virus** spreads via floppy disk. Computer users unwittingly become distributors of the virus. — 1982

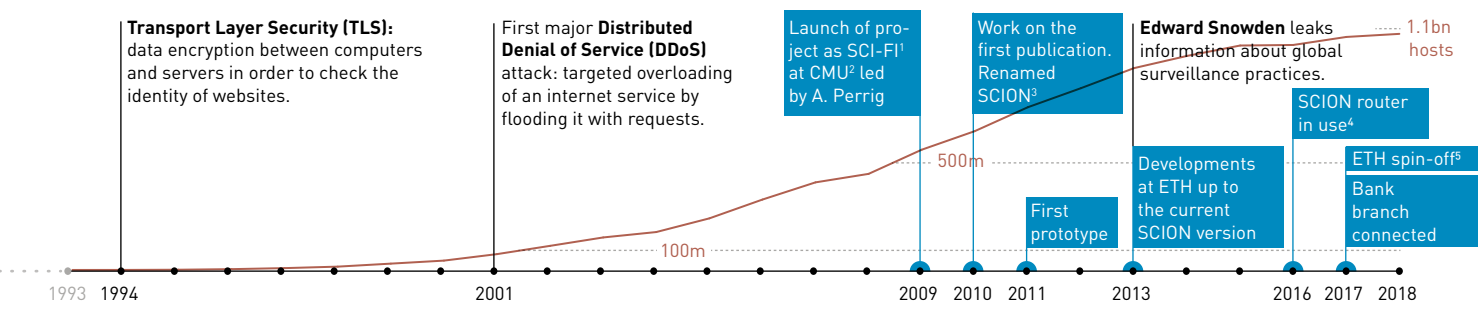
The first **computer worm.** Worms spread independently – all they need is a network connection like the internet. — 1988

The world's first **website:** info.cern.ch. — 1990

1993

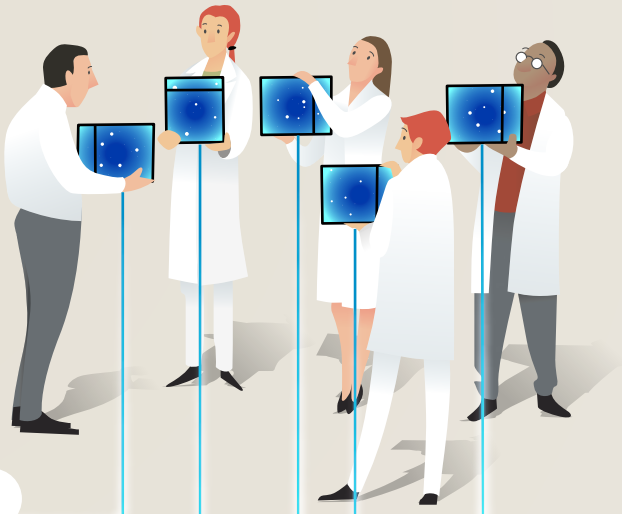
1) SCI-FI – Secure Communication Infrastructure for a Future Internet; 2) CMU – Carnegie Mellon University;
3) SCION – Scalability, Control, and Isolation On Next-Generation Networks; 4) at Swisscom and SWITCH; 5) ETH spin-off Anapaya Systems founded.


Path construction beacons
2
Distributed path server
The path server stores the routing paths between autonomous systems, so it knows how data can be sent securely to the recipient.
4
Protection
The ISD offers special protection against attacks. Classical internet connections are only used when communicating with entities outside the ISD.
3
Sending data
Data are divided and sent over different, secured connection paths. This distribution means the contents are better protected against hacking and spying attacks.
Parts of the data package
Recipients of these data
Autonomous system that sends data


Transport Layer Security (TLS): data encryption between computers and servers in order to check the identity of websites.
First major Distributed Denial of Service (DDoS) attack: targeted overloading of an internet service by flooding it with requests.
Launch of project as SCI-FI[1] at CMU[2] led by A. Perrig
Work on the first publication. Renamed SCION[3]
Edward Snowden leaks information about global surveillance practices.
1.1bn hosts
SCION router in use[4]
ETH spin-off[5]
Bank branch connected
500m
Developments at ETH up to the current SCION version
First prototype
100m
1993
1994
2001
2009
2010
2011
2013
2016
2017
2018

Machines with brains

Machines can learn too. At least when they are supported by software that simulates the functions of the human brain. It is enough to define the basic principles of learning, then the computer learns independently from experience. ETH researchers are using these neural networks to explore unsolved questions, such as the origins of the universe.



1

Models

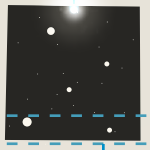
Different mathematical models describe a potential distribution of matter in the universe. But which one is the closest to reality?

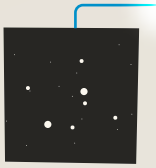
2

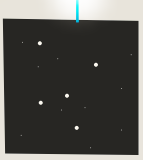
Gathering data

Each of the models creates simulation images of the universe which can then be used to train a neural network.


Model 1


Model 2


Model 3


Model 4


Model 5

3

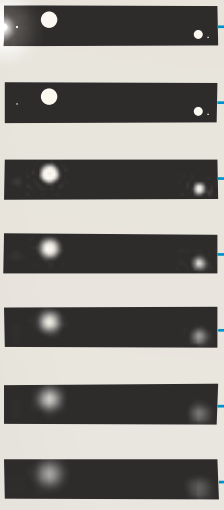
Noise

Genuine telescope images always contain a certain amount of blurring, or "noise". To ensure the neural network is still able to allocate a model at a later stage, more noise is added to the images before each new learning pass.

First pass:
Simulation image without noise

Subsequent passes:
More noise gradually added

Final pass:
Noise at the same level as a real image



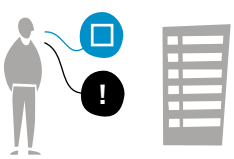
4

Supervised learning

The neural network learns how to identify certain characteristics (e.g. contrast or brightness) in the image so that it can eventually determine the right model.

Learning strategies for neural networks

Machine learning is possible using different strategies. These vary in terms of how and when the neural network receives feedback.



Supervised learning
(As in the above example.) The neural network receives the data and the answer simultaneously, learning to identify the pattern in the process.

Unsupervised learning
The neural network only receives the data and must find a pattern itself.

7

Application

Now real telescope images can be input. The trained network then allocates them to the most probable model of the universe.

6

Learning goal achieved

The goal is achieved once the neural network is able to identify each model, even when faced with significant noise. It arrives at the correct solution autonomously.

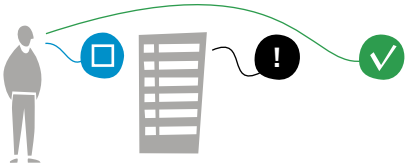
The goal in this sample pass is to attain Model 2

5

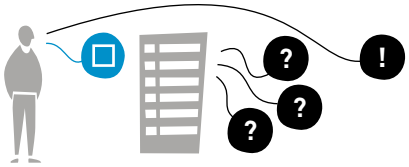
Learning process

The neural network must identify the directional characteristics itself. In the final pass with a realistic noise level, many characteristics need to be analysed to produce the right allocation.

Analysis of a characteristic that brings the neural network closer to the goal



Reinforced learning
The neural network receives the data, gives an answer and gets feedback on whether it was correct.



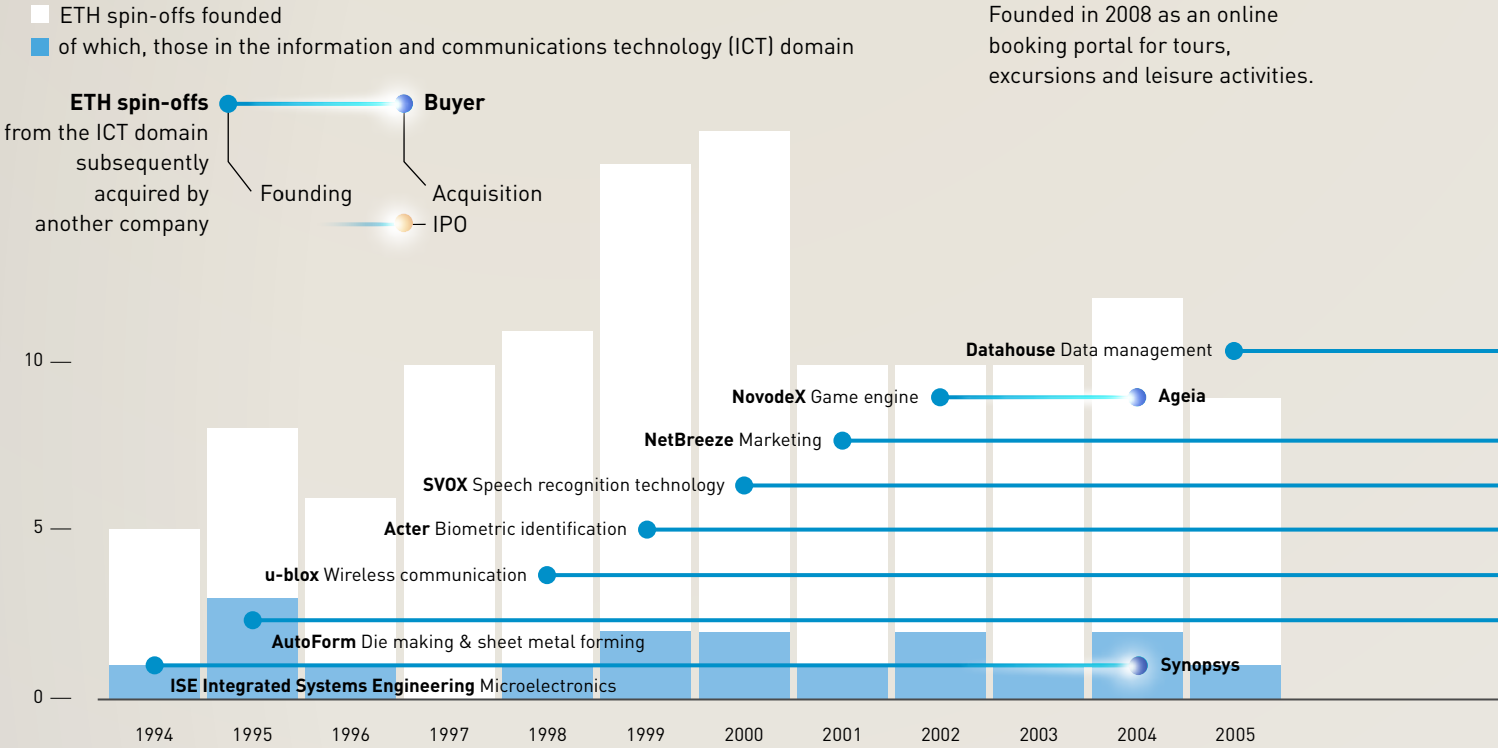
Active learning
The neural network receives the data and poses questions. In the learning process, the way the question is phrased is tailored to ensure that the correct answer can be found in as few concise questions as possible.

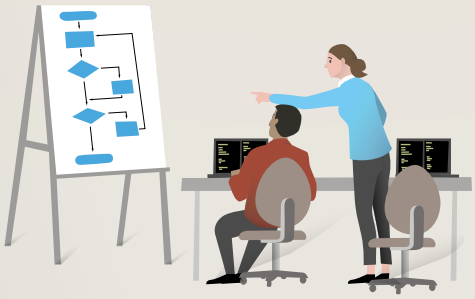
The rewards of digitalisation

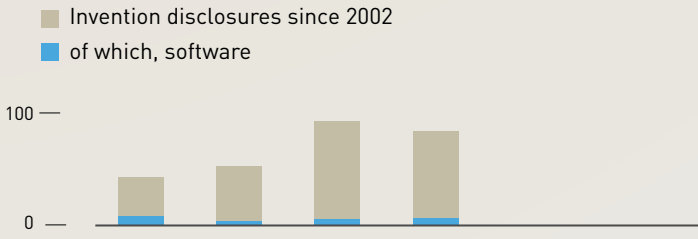
New technologies play a pivotal role in creating added value for Switzerland. Particularly in the digital domain, the number of new spin-offs founded at ETH is booming, promising exciting innovations ranging from augmented reality to plant care.

Dynamic ICT spin-offs from ETH Zurich

GetYourGuide
Founded in 2008 as an online booking portal for tours, excursions and leisure activities.







Views on the risks and rewards of digitalisation

"Research, training and technology transfer at ETH play a key role in developing new digital technologies and putting them to practical use in companies. This boosts competitiveness and the ability to innovate."

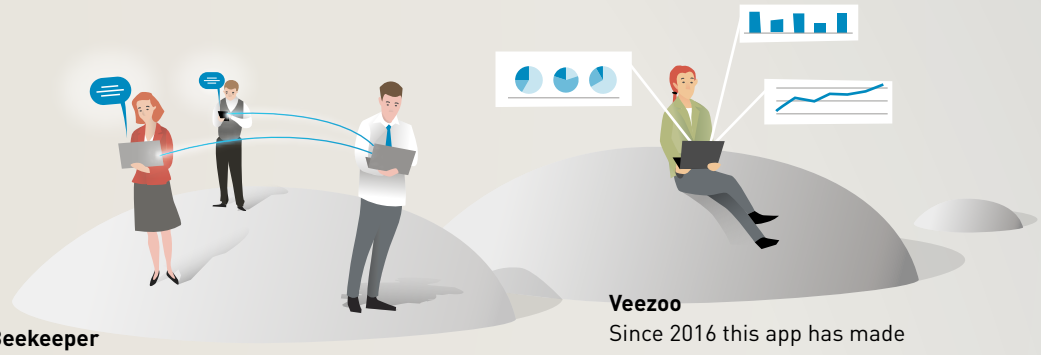
KOF Swiss Economic Institute, ETH Zurich

"Highly trained staff are our most important asset. Almost half of our 250 or so employees have studied at ETH Zurich."

Kurt Biri, Partner at AWK Group

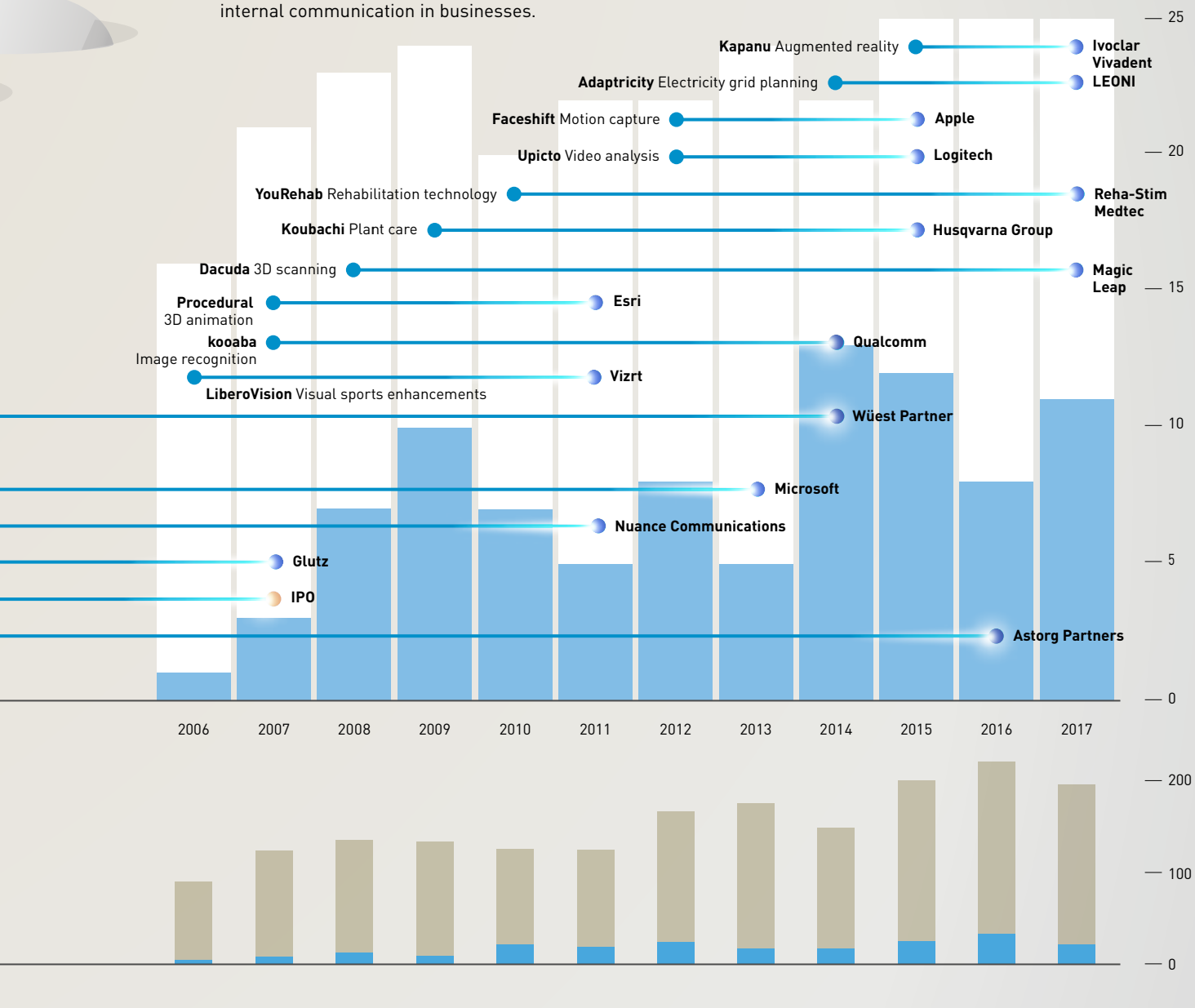
"If Switzerland wants to maintain its successful track record, we must not rest on our laurels: apart from an ecosystem of innovation, which is characterised by an open mindset and a stronger risk appetite, the quality of education and research is also vitally important."

Roger Wüthrich-Hasenböhler, Chief Digital Officer at Swisscom



Beekeeper
Since 2012 this messaging app has offered a digital solution for convenient internal communication in businesses.

Veezoo
Since 2016 this app has made it easier to find, visualise and exploit large quantities of data.



"European studies reveal that around a third of the economic growth seen in recent years has been made possible by digitalisation. We need to invest in the education system, and especially in digital skills!"

Swiss State Secretariat for Economic Affairs (SECO)

"Many of the jobs that will bring us a decent salary and living standard 20 years from now haven't even been created yet. We need suitable opportunities for continuing education and fresh ideas at the university level."

Thomas Dübendorfer, President of the Swiss ICT Investor Club (SICTIC)

"Switzerland has the chance to become one of Europe's leading digital hubs. The risks lie in stiffer global competition. Can teaching, research and industry agree on where to focus their investments? That would be a huge opportunity for Switzerland."

Patrick Warnking, Country Director Google Switzerland

Nicola Spaldin has already received numerous prestigious science awards for her revolutionary research in the field of materials science, including the 2017 L'Oréal-UNESCO for Women in Science Award, the 2012 Max Rössler Prize and the 2015 Körber Prize. But Spaldin is not only an outstanding researcher, she is also a passionate teacher. Three years ago, her students gave the British-born scientist a special honour: the Golden Owl award for her commitment to teaching. Spaldin's research lays the theoretical foundations for understanding and developing so-called multiferroic materials, which have the unique property of being simultaneously magnetic and ferroelectric.

Honours and awards

Every year, many of ETH's scientists receive prizes and awards in recognition of their work. Last year was no exception. Such awards not only enhance the university's outstanding international reputation, but also demonstrate ETH's continuing commitment to providing its researchers with the working environment and infrastructure they need to produce their very best academic performance.

The prestigious grants awarded by the European Research Council (ERC) each year are a key measure of the university's research quality. Two female researchers and one male researcher received a Starting Grant from the ERC for their projects undertaken at ETH. Starting Grants are awarded to support young talents early on in their academic careers. ETH also performed well in respect of Consolidator Grants, which are awarded to researchers at a more advanced stage of their career. A total of five ETH scientists received grants of this type. Applications for ERC Advanced Grants are even more competitive, and here no less than eight ETH scientists were successful, all of them full or associate professors, and three of them winning an Advanced Grant for the second time. These grants are awarded to established researchers with a track record for excellence.

Honorary doctorates

Recipients of honorary doctorates from ETH Zurich: Professor Kip S. Thorne, Professor Françoise Brochard-Wyart, Dr Richard Henderson, Fabio Reinhart, Professor Bruno Reichlin (from left to right).

Honorary doctorates from ETH Zurich
ETH Zurich awards honorary doctorates to acknowledge recipients' outstanding scientific work. This accolade honours their significant achievements in science, teaching and practice, or in the synthesis of research and practical work.

As is customary, the Rector of ETH Zurich awarded the honorary doctorates at ETH Day. A total of five people received an honorary doctorate in 2017. Two such honours were awarded to this year's Nobel laureates in physics and chemistry, respectively: Kip S. Thorne and Richard Henderson.

Professor Bruno Reichlin
In recognition of his exceptional services to architecture as an influential historian, theoretician, conservationist and architect.

Fabio Reinhart
In recognition of his exceptional services to architecture as an influential university lecturer and architect.

Dr Richard Henderson, FRS
In recognition of his groundbreaking work in the development of electron microscopy for the high-resolution examination of the structures of biological macromolecules.

Professor Françoise Brochard-Wyart
For her fundamental insights into capillarity phenomena and their application in living systems.

Professor Kip S. Thorne
For his exceptional scientific achievements, in particular his decisive contributions to the discovery of gravitational waves, and his exemplary efforts to bring the fundamental sciences to a wider public audience.

Honours and prizes awarded to members of ETH

A

Professor Ruedi Aebersold, D-BIOL
Barry L. Karger Medal Award, Barnett Institute of Chemical and Biological Analysis at Northeastern University, United States of America

Dr Uria Alcolombri, D-BAUG
Fellowship, Human Frontier Science Program (HFSP), France

Professor Göran Andersson, D-ITET
Doctor of Engineering, honoris causa, University of Waterloo, Canada

Professor Ueli M. Angst, D-BAUG
Robert L'Hermite Medal, RILEM, France

B

Professor Nenad Ban, D-BIOL
Ernst Jung Prize for Medicine, Jung Foundation, Germany

Professor Johann Blatter, D-PHYS
Abrikosov Prize in Vortex Physics, International Vortex Physics Conference, Brazil

Professor Jeffrey Bode, D-CHAB
Yoshida Lectureship, International Organic Chemistry Foundation, Japan; Jones Lecture, Queen's University, Canada

Professor Peter Bühlmann, D-MATH
Doctor honoris causa, Université catholique de Louvain, Belgium

Professor Joachim M. Buhmann, D-INFK
Honorary Member, Deutsche Arbeitsgemeinschaft für Mustererkennung (DAGM), Germany; Member, Academy of Engineering Sciences (SATW), Switzerland

C

Professor Erick M. Carreira, D-CHAB
Chair, EFMC-ASMC'17, European Federation for Medicinal Chemistry (EFMC), Belgium; Member, American Academy of Arts and Sciences, United States of America

Professor Adam Caruso, D-ARCH
Fritz Höger Award 2017/Grand Prix, Backstein.com, Germany

Professor Margarita Chli, D-MAVT
Prix Zonta, Zonta Club, Switzerland and Liechtenstein

Professor Kees Christiaanse, D-ARCH
ARC17 Oeuvre Award, de Architect, Netherlands

Professor Christophe Copéret, D-CHAB
Wheland Medal, University of Chicago, United States of America

D

Dr Johannes Deiglmayr, D-CHAB
Nernst-Haber-Bodenstein Prize, German Bunsen Society for Physical Chemistry (DBG), Germany

Professor Andrew deMello, D-CHAB
WIN Distinguished Lecture, University of Waterloo, Canada

Professor François Diederich, D-CHAB
Rebek-Sessler Lectureship, The Scripps Research Institute, United States of America

Professor Silvia Dorn, D-USYS
Honorary Doctor of Science, Newcastle University, United Kingdom

E

Professor Paul Embrechts, D-MATH
Harald Bohr Lecture, University of Copenhagen, Denmark; Hung Hing Ying Distinguished Visiting Professor, University of Hong Kong, China; Honorary Member, Swiss Association of Actuaries, Switzerland; Doctor of Science honoris causa, City, University of London, United Kingdom

Professor Tilman Esslinger, D-PHYS
ERC Advanced Grant, European Research Council, Belgium

F

Professor Jérome Faist, D-PHYS
Medal for Environmental and Safety Technologies, IEEE, United States of America

Professor Andreas Fichtner, D-ERDW
Member, Young Academy of Europe, United Kingdom

Professor Alessio Figalli, D-MATH
Fellow, European Academy of Sciences (EURASC), Belgium; Feltrinelli Prize, Accademia Nazionale dei Lincei, Italy

Professor Emilio Frazzoli, D-MAVT
Kiyo Tomiyasu Award, IEEE, United States of America

Professor Klaus Fröhlich, D-ITET
Distinguished Guest Professor, Hunan University, China

Professor Martin Fussenegger, D-BSSE
Member, European Molecular Biology Organisation (EMBO), Germany; Foreign Member, National Academy of Engineering (NAE), United States of America

G

Professor Pietro Gambardella, D-MATL
Distinguished Lecture Series, Universidad Autónoma de San Luis Potosí, Mexico

Professor Andreas Geiger, D-INFK
Heinz Maier-Leibnitz Prize, Deutsche Forschungsgemeinschaft (DFG), Germany

Professor Vadim Geshkenbein, D-PHYS
Abrikosov Prize in Vortex Physics, International Vortex Physics Conference, Brazil

Professor Adrienne Grêt-Regamey, D-BAUG
ERC Starting Grant, European Research Council, Belgium

Professor Markus Gross, D-INFK
Member, National Academy of Engineering of Korea, South Korea

Professor Hansjörg F. Grützmacher, D-CHAB
Wilhelm Klemm Prize, Gesellschaft Deutscher Chemiker (GDCh), Germany

H

Professor Christoph A. Heinrich, D-ERDW
Huaying Grand Master Chair, Nanjing University, China; R.A.F. Penrose Gold Medal, Society of Economic Geologists, United States of America

Professor Otmar Hilliges, D-INFK
ERC Starting Grant, European Research Council, Belgium

Professor Juraj Hromkovic, D-INFK
Pribina Cross, 1st class, Slovak Republic

Professor Sebastian Huber, D-PHYS
ERC Consolidator Grant, European Research Council, Belgium

Professor Konrad Hungerbühler, D-CHAB
Wöhler Prize for Sustainable Chemistry, Gesellschaft Deutscher Chemiker (GDCh), Germany

I

Dr Maria Ibáñez, D-CHAB
Ruzicka Prize, ETH Zurich, Switzerland

J

Professor Gunnar Jeschke, D-CHAB
Silver Medal – Instrumentation, International EPR (ESR) Society, United States of America

K

Dr Lars Kasper, D-ITET
Junior Fellow, International Society for Magnetic Resonance in Medicine (ISMRM), United States of America

Professor Ursula Keller, D-PHYS
Weizmann Women and Science Award, Weizmann Institute of Science, Israel

Professor Mustafa Khammash, D-BSSE
ERC Advanced Grant, European Research Council, Belgium

Professor Dennis M. Kochmann, D-MAVT
ERC Consolidator Grant, European Research Council, Belgium

Professor Sebastian Kozerke, D-ITET
Fellow, International Society for Magnetic Resonance in Medicine (ISMRM), United States of America

L

Professor Wolfgang Langhans, D-HEST
2017 Solomon Berson Distinguished Lectureship Award, American Physiological Society, United States of America

Professor Antonio Lanzavecchia, D-BIOL
Robert Koch Award, Robert Koch Foundation, Germany

Professor Juerg Leuthold, D-ITET
Werner Siemens Foundation Project, Werner Siemens Foundation, Switzerland

Professor Johan Lilliestam, D-USYS
ERC Starting Grant, European Research Council, Belgium

Professor Simon J. Lilly, D-PHYS
Carl Sagan Memorial Award, American Astronautical Society, United States of America; Herschel Medal, Royal Astronomical Society (RAS), United Kingdom

Professor Jörg F. Löffler, D-MATL
Distinguished Membership, European Academy of Sciences (EURASC), Belgium

Professor Mathieu Luisier, D-ITET
Werner Siemens Foundation Project, Werner Siemens Foundation, Switzerland

M

Professor Marloes Maathuis, D-MATH
Fellow, Institute of Mathematical Statistics (IMS), United States of America

Professor Isabelle Mansuy, D-HEST
Member, European Academy of Sciences (EURASC), Belgium

Professor Joao Matos, D-BIOL
Young Investigator, European Molecular Biology Organisation (EMBO), Germany

Professor Kristopher McNeill, D-USYS
Fellow, American Association for the Advancement of Science (AAAS), United States of America; Kappe Lecturer, Penn State University, United States of America

Professor Beat H. Meier, D-CHAB
ERC Advanced Grant, European Research Council, Belgium

Professor Dennis Meier, D-MATL
Gustav Hertz Prize, Deutsche Physikalische Gesellschaft (DPG), Germany

Professor Frédéric Merkt, D-CHAB
ERC Advanced Grant, European Research Council, Belgium

Professor Raffaele Mezzenga, D-HEST
Fellow, American Physical Society (APS), United States of America

Professor Siddhartha Mishra, D-MATH
ERC Consolidator Grant, European Research Council, Belgium

Professor Massimo Morbidelli, D-CHAB
Excellence in Process Development Research Award, American Institute of Chemical Engineers (AIChE), United States of America

Professor Ralph Müller, D-HEST
ERC Advanced Grant, European Research Council, Belgium; Viktor Kaplan Lecture, Austrian Academy of Sciences (ÖAW), Austria

Professor Onur Mutlu, D-INFK
Distinguished Lecture, INESC-ID, Lisbon, Portugal

N

Professor Bradley J. Nelson, D-MAVT
ERC Advanced Grant, European Research Council, Belgium

Professor Torbjörn Netland, D-MTEC
Shingo Research Award, Utah State University, United States of America

Professor David J. Norris, D-MAVT
Nano Lectureship Award, American Chemical Society (ACS), United States of America

O

Professor Dani Or, D-USYS
John Dalton Medal, European Geosciences Union (EGU), Germany

P

Dr Salvador Pané Vidal, D-MAVT
ERC Consolidator Grant, European Research Council, Belgium

Professor Michele Parrinello, D-CHAB
Dreyfus Prize, The Camille and Henry Dreyfus Foundation, United States of America

Professor Javier Pérez-Ramirez, D-CHAB
Sustainable Energy Award, Royal Society of Chemistry, United Kingdom

Professor Adrian Perrig, D-INFK
Fellow, Association for Computing Machinery (ACM), United States of America

Professor Jörn Piel, D-BIOL
ERC Advanced Grant, European Research Council, Belgium

Professor Rafael Polania, D-HEST
ERC Starting Grant, European Research Council, Belgium

Professor Sotiris E. Pratsinis, D-MAVT
Reuel Shinnar Lecture, City University of New York, United States of America

Professor Alexander M. Puzrin, D-BAUG
Adjunct Professor, University of Western Australia, Australia

Q

Professor Martin Quack, D-CHAB
Foreign Honorary Member, American Academy of Arts and Sciences, United States of America

R

Professor Alexandre Refregier, D-PHYS
Adjunct Professor, Tata Institute of Fundamental Research, India

Professor Sereina Zoe Riniker, D-CHAB
Silver Jubilee Prize, Molecular Graphics and Modelling Society (MGMS), United Kingdom

S

Professor Kevin Schawinski, D-PHYS
MERAC Prize, European Astronomical Society (EAS), Switzerland

Professor Timm Schroeder, D-BSSE
Erwin Schrödinger Prize, Helmholtz Association, Germany

Professor Lesya Shchutska, D-PHYS
ERC Starting Grant, European Research Council, Belgium

Professor Chih-Jen Shih, D-CHAB
Ruzicka Prize, ETH Zurich, Switzerland; Class of Influential Researchers, American Chemical Society (ACS), United States of America

Professor Olga Sorkine-Hornung, D-INFK
Outstanding Technical Contributions Award, EUROGRAPHICS Association, France; Rössler Prize, ETH Zurich, Switzerland

Professor Nicola A. Spaldin, D-MATL
Fellow, European Academy of Sciences (EURASC), Belgium; Women in Science Award, L'Oréal Foundation and UNESCO, France; Lise Meitner Lecture, Deutsche Physikalische Gesellschaft (DPG), Germany and Österreichische Physikalische Gesellschaft (ÖPG), Austria; Mid-Career Researcher Award, Materials Research Society, United States of America; Fellow, The Royal Society, United Kingdom

Professor Aldo Steinfeld, D-MAVT
Achievement Through Action Award, International Solar Energy Society (ISES), Germany

Professor Roman Stocker, D-BAUG
Simons Foundation Fund, Simons Foundation, United States of America

Professor Benny Sudakov, D-MATH
Robinson Lecture, Yale University, United States of America

T

Professor Paul J. Tackley, D-ERDW
Fellow, American Geophysical Union (AGU), United States of America

Professor Antonio Togni, D-CHAB
ACS Award, American Chemical Society (ACS), United States of America

V

Professor Luc Van Gool, D-ITET
PAMI Distinguished Researcher, IEEE, United States of America

Professor Viola Vogel, D-HEST
Einstein BIH Visiting Fellowship, Stiftung Charité, Germany

Professor Georg von Krogh, D-MTEC
Advisory Board, Research Council of Norway, Norway

W

Professor Achim Walter, D-USYS
Honorary Member, Swiss Association of Agronomists and Food Scientists (SVIAL), Switzerland

Dr Joe Warrington, D-ITET
Simons Fellowship, University of California, Berkeley, United States of America

Professor Robert Weismantel, D-MATH
Humboldt Research Award, Humboldt Foundation, Germany

Professor Helma Wennemers, D-CHAB
Inhoffen Medal, Helmholtz Centre for Infection Research, Germany; Melvin Calvin Lecture, University of California, Berkeley, United States of America

Professor Sabine Werner, D-BIOL
Ernst Klenk Lecture, Center for Molecular Medicine, Cologne, Germany

Professor Wendelin Werner, D-MATH
Honorary doctorate, City University of Hong Kong, China

Dr Emma Wetter Slack, D-BIOL
Latsis Prize, Fondation Latsis Internationale, Switzerland

Professor Thomas Willwacher, D-MATH
Floer Lectures, Ruhr-Universität Bochum, Germany; Séminaire Nicolas Bourbaki, France

Professor Erich J. Windhab, D-HEST
Hokkaido University Ambassador, University of Hokkaido, Japan

Professor Lenny Winkel, D-USYS
Distinguished Lecturer, European Association of Geochemistry (EAG), France

Professor Hans Jakob Wörner, D-CHAB
ERC Consolidator Grant, European Research Council, Belgium

Professor Kurt Wüthrich, D-BIOL
Endel Lippmaa Memorial Lecture, Estonian Academy of Sciences, Estonia; Genome Valley Excellence Award, BioAsia, Hyderabad, India; Eraldo Antonini Lecture, Italian Biochemical Society, Italy; Fellow, Journal of Magnetic Resonance (JMR), United States of America

Professor Anton Wutz, D-BIOL
Member, European Molecular Biology Organisation (EMBO), Germany

Z

Professor Renato Zenobi, D-CHAB
ERC Advanced Grant, European Research Council, Belgium; Xing Da Lectureship, Peking University, China

Many paths lead to ETH Zurich. After three years of baccalaureate school – known as *Gymnasium* in Switzerland – **Lea Huonder** made a bold decision: she would embark on an IT apprenticeship at ETH Zurich, thereby turning her hobby into a profession. Now 22, Huonder is currently in the fourth year of her apprenticeship as a systems engineer and feels very comfortable working in this traditionally rather male-dominated area. She is considering continuing her career path at ETH by studying computer science.

Human resources and infrastructure

People from many different cultural backgrounds and disciplines work at ETH Zurich. Our diversity encourages excellence, but also obliges us to work towards a common understanding about proper ways to interact with one another. The Respect campaign launched in autumn 2017 used provocative slogans to urge all members of the university to be aware of – and never overstep – personal boundaries.

A milestone was reached with the expansion of the Institute of Agricultural Sciences: ETH Zurich, the University of Zurich and the canton of Zurich opened the new AgroVet-Strickhof agricultural training and research centre in Lindau. The state-of-the-art facilities at this centre will allow interdisciplinary research with direct links to agricultural practice.

ETH Zurich will also continue to grow in the coming years. The Executive Board launched discussions about the university's future development as part of the ETH+ programme, which will initiate new forms of collaboration built on the basic sciences. Free of departmental boundaries, new colleagues will strengthen and cross-fertilise interdisciplinary initiatives, helping to expand capacity and improve quality in teaching, research, the transfer of knowledge and technology, and engagement with stakeholders.

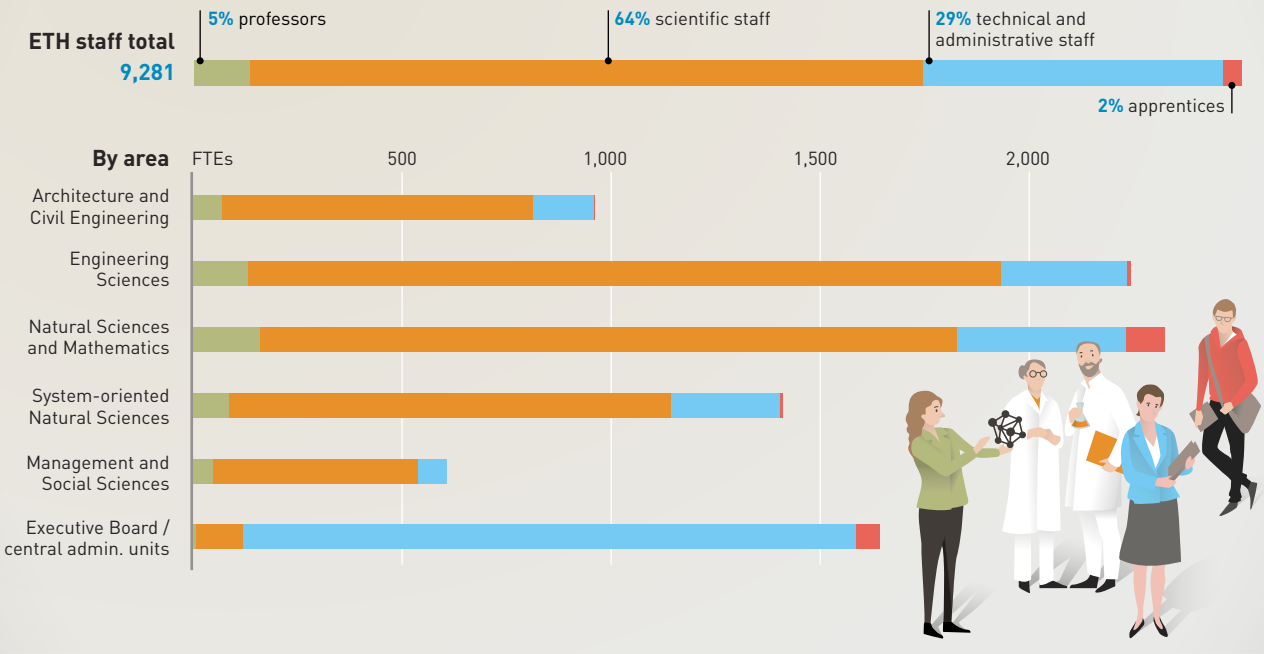
Staff by function

ETH Zurich (consolidated) Full-time equivalents (FTEs), at the end of 2017 (reporting date) or annual average	FTEs annual average						FTEs on reporting date at y/e
	2016 Total	2017 Total	Women	Inter-national staff	Increase Absolute	Increase in %	2017 Total
Total staff [1]	**9,043.2**	**9,281.1**	**32.4%**	**55.8%**	**237.9**	**2.6%**	**9,435.8**
of which permanent members of staff	2,858.5	2,955.1			96.6	3.4%	2,983.0
Professors [2]	**476.2**	**490.8**	**14.0%**	**67.5%**	**14.6**	**3.1%**	**500.7**
Full professors	390.6	401.1	12.2%	65.4%	10.5	2.7%	408.3
Assistant professors	85.6	89.7	22.1%	76.5%	4.1	4.8%	92.5
Scientific staff	**5,825.2**	**5,964.1**	**29.5%**	**70.2%**	**138.9**	**2.4%**	**6,050.6**
Permanent scientific staff	254.5	257.5	15.6%	43.7%	3.0	1.2%	257.8
Temporary scientific staff	5,197.1	5,321.0	29.7%	74.2%	123.9	2.4%	5,420.0
Senior assistants, scientific staff (temporary)	604.1	616.0	23.5%	71.8%	11.9	2.0%	626.5
Postdoctoral researchers, scientific research assistants II	1,163.0	1,107.0	30.2%	88.4%	–56.0	–4.8%	1,118.1
Scientific research assistants I	3,429.9	3,598.0	30.6%	70.2%	168.0	4.9%	3,675.5
Teaching/research assistants	373.6	385.6	35.9%	33.8%	12.0	3.2%	372.8
Technical and administrative staff	**2,571.8**	**2,658.4**	**42.5%**	**24.4%**	**86.5**	**3.4%**	**2,714.5**
of which permanent members of staff	2,217.4	2,298.4			81.0	3.7%	2,330.4
Technical and IT staff	1,371.6	1,427.5	18.9%	29.2%	55.9	4.1%	1,461.7
Administrative staff	1,200.3	1,230.9	69.9%	18.7%	30.6	2.6%	1,252.7
Apprentices	**169.9**	**167.8**	**30.0%**	**7.3%**	**–2.1**	**–1.2%**	**170.0**

[1] Including 95.8 FTEs at Singapore SEC Ltd. (SEC) on average in 2017 (108.8 FTEs on the reporting date).
[2] Headcount 2017: 531 (incl. professors with appointments at other institutions).

www.ethz.ch/staff-stats

ETH staff by area (2017)



Staff by area

(annual average at the end of the year)

Total staff	FTEs annual average						FTEs on reporting date at y/e
					Increase		
Full-time equivalents (FTEs) at the end of 2017 (reporting date) or annual average[1]	2016 Total	2017 Total	Women	International staff	Absolute	in %	2017 Total
ETH Zurich (consolidated)	**9,043.2**	**9,281.1**	**32.4%**	**55.8%**	**237.9**	**2.6%**	**9,435.8**
Departmental total	**7,462.5**	**7,542.2**	**31.2%**	**62.1%**	**79.7**	**1.1%**	7,646.5
Architecture and Civil Engineering	985.7	961.1	32.6%	55.1%	–24.6	–2.5%	980.3
Architecture	416.9	395.2	38.4%	53.5%	–21.7	–5.2%	417.8
Civil, Environmental and Geomatic Engineering	568.8	565.9	28.5%	56.2%	–2.8	–0.5%	562.5
Engineering Sciences	2,167.4	2,241.8	21.2%	66.9%	74.4	3.4%	2,289.7
Mechanical and Process Engineering	715.3	727.8	17.9%	62.8%	12.5	1.8%	742.1
Information Technology and Electrical Engineering	561.3	579.9	17.3%	64.9%	18.6	3.3%	598.6
Computer Science	372.5	404.8	18.3%	68.1%	32.3	8.7%	410.7
Materials	228.7	230.7	27.0%	65.6%	2.0	0.9%	232.8
Biosystems Science and Engineering	289.7	298.6	35.8%	79.9%	8.9	3.1%	305.5
Natural Sciences and Mathematics	2,339.2	2,322.7	30.8%	61.9%	–16.5	–0.7%	2,293.1
Mathematics	287.8	283.3	22.7%	62.1%	–4.5	–1.6%	246.9
Physics	612.0	624.7	19.3%	57.8%	12.8	2.1%	629.1
Chemistry and Applied Biosciences	806.5	800.9	32.1%	61.2%	–5.6	–0.7%	814.9
Biology	633.0	613.8	44.5%	66.8%	–19.2	–3.0%	602.3
System-oriented Natural Sciences	1,397.2	1,409.7	44.2%	59.3%	12.5	0.9%	1,448.1
Earth Sciences	326.9	320.3	34.4%	67.9%	–6.6	–2.0%	319.4
Environmental Systems Science	626.0	624.0	46.0%	57.8%	–2.1	–0.3%	631.9
Health Sciences and Technology	444.3	465.5	48.7%	55.4%	21.2	4.8%	496.8
Management and Social Sciences	573.0	606.8	37.9%	62.8%	33.9	5.9%	635.3
Management, Technology and Economics	317.6	325.9	37.9%	66.8%	8.3	2.6%	337.0
Humanities, Social and Political Sciences	255.4	281.0	37.8%	58.1%	25.6	10.0%	298.3
Teaching and research facilities outside the academic departments, others[2]	**337.9**	**469.9**	**32.1%**	**58.5%**	**131.9**	**39.0%**	**497.7**
Executive Board, staff units and administrative departments	**1,242.8**	**1,269.1**	**39.5%**	**17.5%**	**26.3**	**2.1%**	**1,291.5**
Executive Board and staff units	105.4	116.2	61.5%	26.1%	10.7	10.2%	120.7
Administrative departments	1,137.3	1,152.9	37.2%	16.7%	15.6	1.4%	1,170.8
Corporate Communications	27.7	27.5	61.8%	24.1%	–0.2	–0.7%	27.3
Academic Services	57.9	58.3	64.1%	13.1%	0.3	0.5%	57.5
Educational Development and Technology	22.4	27.4	45.8%	24.7%	5.0	22.6%	27.9
Student Services	15.4	15.9	79.1%	4.0%	0.5	3.3%	16.2
Controlling	20.7	19.9	51.9%	5.0%	–0.9	–4.2%	20.1
Financial Services	15.2	17.4	40.3%	9.7%	2.2	14.3%	18.3
Accounting	40.7	39.6	47.9%	18.6%	–1.1	–2.6%	39.8
Facility Management	193.9	191.1	18.0%	20.9%	–2.8	–1.4%	191.1
ETH Library	227.0	219.6	58.8%	15.7%	–7.4	–3.2%	217.2
Real Estate	68.3	68.8	27.6%	13.5%	0.5	0.7%	70.7
IT Services	250.1	266.1	12.7%	19.3%	16	6.4%	274.5
Human Resources	62.8	65.7	70.7%	8.4%	2.9	4.6%	70.2
Services	93.5	94.4	40.7%	12.2%	0.9	0.9%	97.8
Safety, Security, Health and Environment	38.8	40.0	29.3%	20.7%	1.2	3.1%	41.6

[1] The average number of employees at the end of both the reporting year and the previous year is also based on the current organisational structure of ETH Zurich as at December 2017. Since 2017, both the staff numbers and the calculation are reported on a consolidated basis; the figures shown in the table for the reporting year 2017 therefore include the staff at ETH Singapore SEC Ltd.

[2] "Teaching and research facilities outside the academic departments, others" refers to Singapore–ETH Centre (SEC), Institute of Science, Technology, and Policy (ISTP), Collegium Helveticum, Congressi Stefano Franscini, ETH Institute for Theoretical Studies (ITS), Wyss Translational Center Zurich (Wyss Zurich), Functional Genomic Center Zurich, NEXUS Personalized Health Technologies, FIRST Lab, Binnig and Rohrer Nanotech. Center, ScopeM, ETH Phenomics Center, Swiss Seismological Service (SED), CSCS, AgroVet-Strickhof and other central projects. The staff of the fully consolidated unit ETH Singapore SEC Ltd. are also included (108.8 FTEs as at 31 December 2017 and 95.8 FTEs on average in 2017).

FLEXIBLE WORKPLACE

Working from home or on the move

ETH Zurich offers its employees attractive working conditions, including the possibility of working from home and mobile working. This requires trust and good communication.

Whether an employee works from home on certain days of the week, or works in the field during a project: ETH Zurich supports flexible ways of working as part of a dynamic work culture. With this in mind, it has created websites containing relevant leaflets and forms. "We want to encourage dialogue between staff and supervisors to make the most of the opportunities offered by flexible working," says Lukas Vonesch, Head of Human Resources.

Creating attractive working conditions

These initiatives have arisen out of the university's desire to create attractive working conditions and allow staff to achieve a good work-life balance. "But it also places a greater onus on employees to work independently and responsibly," says Vonesch, adding that trust, communication, consideration and cooperation are essential.

Working from home and mobile working are open to all employees, but they cannot demand it as a right. "The extent to which flexible ways of working are possible in a specific work situation or team is decided by supervisors," says Vonesch. The most important thing is that a person's integration within the team should not suffer. ■

www.ethz.ch/flexible-working

We want to encourage dialogue to make the most of the opportunities offered by flexible working.

ETH LEADS RANKING

The world's most international university

Times Higher Education (THE) has ranked ETH Zurich the most international university in the world. The magazine singled out the global outlook of ETH as a key factor behind its success. ETH President Lino Guzzella emphasises the importance of internationalism for Switzerland's success: "It enables ETH to prepare its graduates for global competition. It's a matter of attracting the best talents from Switzerland and around the world to ETH, and creating ideal conditions for generating new ideas and transferring them to society." Internationalism has always been essential to ETH Zurich's success. The university's international outlook goes right back to its founding in 1855. Today it has links with over 8,000 research partners worldwide. ■

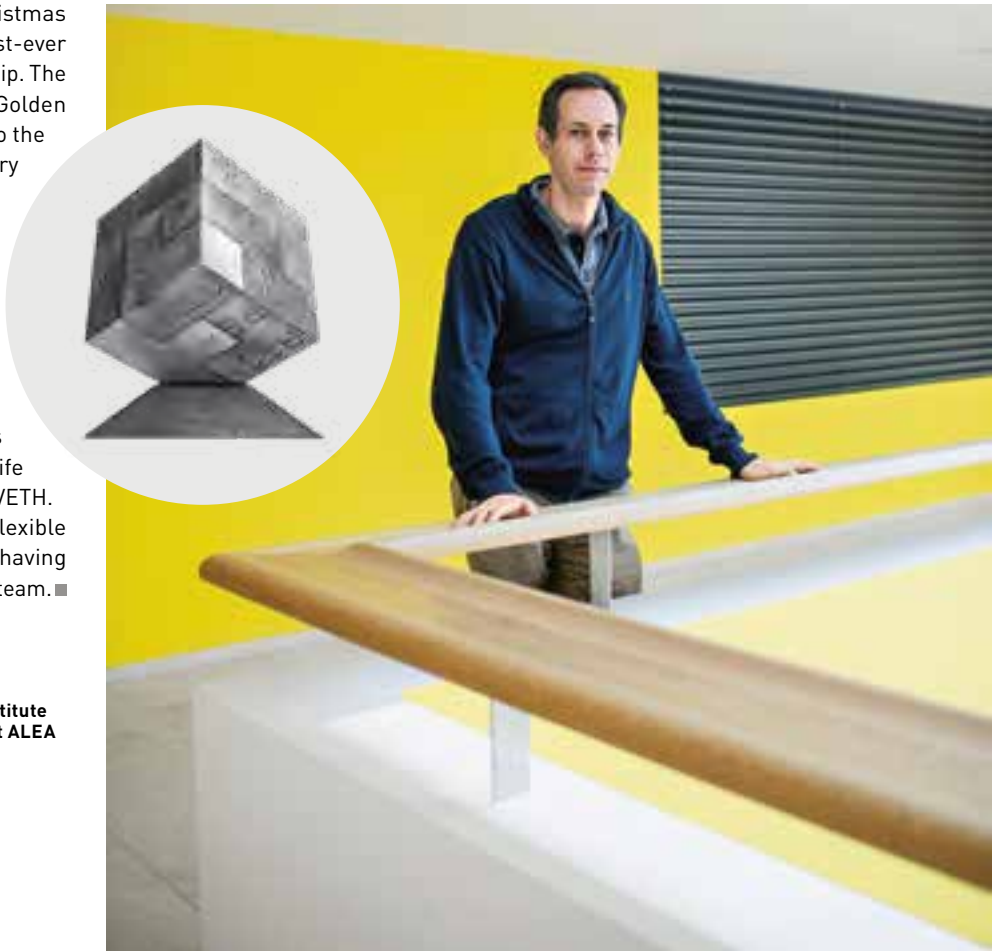
www.ethz.ch/international-university

ALEA AWARD FOR EXEMPLARY LEADERSHIP

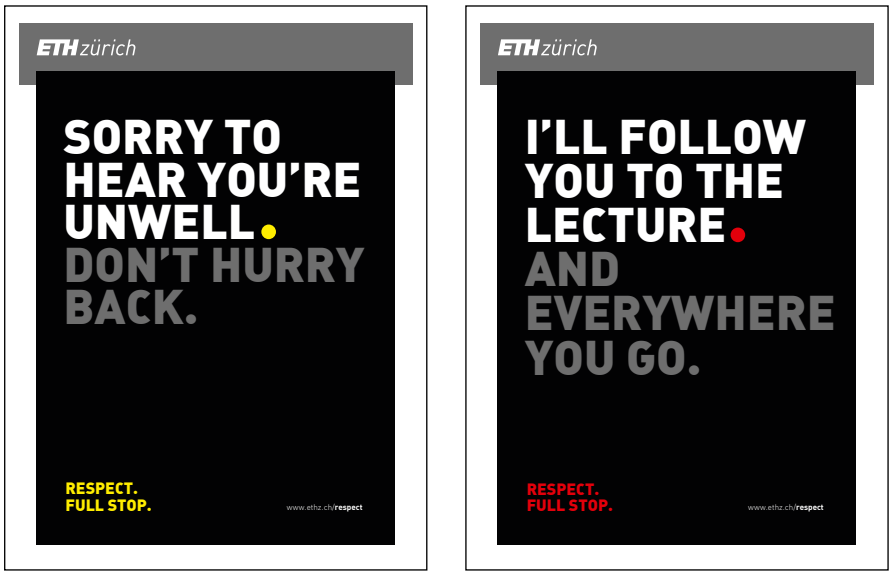
Award goes to Renato Renner

During the Executive Board's Christmas reception, AVETH presented the first-ever ALEA Award for exemplary leadership. The accolade is the successor to the Golden Tricycle, which has been awarded to the most family-friendly managers every year since 2007. It honours people who provide motivational leadership, creating an environment characterised by commitment, diversity, respect and flexibility. The first winner of the prize is Renato Renner, Professor at the Institute for Theoretical Physics. "As the father of four children, he is a walking example of the work-life balance," says Isabella Schalko of AVETH. Renner allows his staff to work flexible hours and places great value on having a versatile and well-balanced work team. ■

www.ethz.ch/alea-award



Renato Renner, ETH professor at the Institute of Theoretical Physics, received the first ALEA Award.



Since 2004 there have been regular Respect campaigns to raise awareness of inappropriate behaviour and to draw attention to the university's Code of Conduct.

RESPECT CAMPAIGN

Not overstepping boundaries

Posters displaying the snappy phrase "Respect. Full stop." call on ETH members to be aware of – and never overstep – individual boundaries. The Respect campaign was launched in the autumn and will be continued in Spring Semester 2018.

"Of course I'll help. If you come out on a date." reads one catchphrase on the flyers and posters. Another says: "You're smart. For a woman." The provocative slogans all have one thing in common: a full stop separates two contrasting statements, one neutral and one disrespectful. "The point where a comment or gesture is perceived as discriminating or offensive is largely a matter of personal judgment," says Lukas Vonesch, Head of Human Resources at ETH Zurich. "What is important is that everyone knows their own boundaries and makes others aware of them – in other words, knowing when to make a full stop."

Fostering a culture of respect

This is exactly the idea behind the Respect campaign. "The purpose of our campaign is to make ETH members more aware of their personal responsibility to show respect," explains Professor Renate Schubert, the Associate Vice President for Equal Opportunities. She is responsible for the campaign, along with Human Resources, the Safety, Security, Health and Environment department (SSHE), ETH Corporate Communications and an external agency. At the start of 2018 a new Respect Code of Conduct was launched, detailing how ETH members should treat each other respectfully and making clear what types of behaviour will not be tolerated at the university. President Lino Guzzella stresses the importance of regular campaigns of this type at institutions such as ETH: "Not only students, but also many of our staff and researchers, are often only with us for a relatively short time. We therefore need to regularly communicate the importance of our guiding principles and values." ■

www.ethz.ch/respect

The provocative slogans all have one thing in common: a full stop separates the neutral from the disrespectful statement.

SENIOR SCIENTISTS

Profiles, paths and priorities

Senior scientists play an important role in teaching, research and knowledge transfer at ETH Zurich. The strategic goal is to ensure that the number of senior scientists is roughly equal to the number of professorships. As scientific staff on permanent contracts working for a professorship, they run courses and supervise doctoral theses. They conduct their own research projects and participate in specialist bodies and research partnerships. Some senior scientists also manage research facilities and technology platforms.

To help shape their career path, ETH Zurich has defined different profiles for senior scientists and created a framework for their personal development and contribution to excellence in research and teaching. ■

GOOD SCIENTIFIC PRACTICE

Contact persons for good scientific practice

Researchers at ETH Zurich enjoy a work and research culture that fosters excellence. This culture in turn depends upon researchers upholding the values of scientific integrity, intellectual honesty and truthfulness in their work.

Establishing standards

To align the principles of good scientific practice (GSP) as closely as possible with the subject-specific requirements of each discipline, ETH Zurich decided in 2017 that in each department a professor should fill the new role of GSP contact person. He or she will help to establish standards and support corresponding measures by research groups, such as regulating the authorship of publications. The 16 researchers also form a GSP committee which advises the Executive Board, promotes dialogue and ensures a common approach. ■

New professorships

FULL PROFESSORS

New appointments

Professor Ulrik Brandes,
Social Networks (1.11.2017),
D-GESS, formerly Professor
at the University of Konstanz, Germany

Professor Denis Burdakov,
Neuroscience (1.9.2017),
D-HEST, formerly Professor at
King's College London, United Kingdom

Professor Maarten Delbeke,
History and Theory of Architecture
(1.1.2017), D-ARCH, formerly Professor
at Ghent University, Belgium

Professor Manu Kapur,
Learning Sciences and Higher Education
(1.1.2017), D-GESS, formerly Professor at
The Education University of Hong Kong,
China

Professor Dennis Kochmann,
Mechanics and Materials (1.4.2017),
D-MAVT, formerly Professor at
California Institute of Technology,
Pasadena, United States of America

Professor Motohiko Murakami,
Experimental Mineral Physics (1.8.2017),
D-ERDW, formerly Associate Professor
at Tohoku University, Sendai, Japan

Professor Federica Sallusto,
Medical Immunology (1.2.2017), D-BIOL,
formerly Head of the Cellular Immun-
ology Laboratory and the Center of
Medical Immunology at Università della
Svizzera Italiana, Bellinzona, Switzerland

Professor Gerhard Schratt,
Systems Neuroscience (1.8.2017),
D-HEST, formerly Professor and Director
of the Institute for Physiological
Chemistry at Philipps-Universität
Marburg, Germany

Professor Eftychia Vayena,
Bioethics (1.9.2017), D-HEST, formerly
SNSF Professor at the University of
Zurich, Switzerland

Promotions

Professor Irena Hajnsek,
Earth Observation and Remote Sensing
(1.1.2017), D-BAUG, formerly Associate
Professor in the same subject area

Professor Markus Niederberger,
Multifunctional Materials (1.1.2017),
D-MATL, formerly Associate Professor
in the same subject area

Professor Christian Wolfrum,
Translational Nutrition Biology (1.1.2017),
D-HEST, formerly Associate Professor in
the same subject area

Professor Karsten M. Borgwardt,
Data Mining (1.4.2017), D-BSSE,
formerly Associate Professor
in the same subject area

Professor Andreas Krause,
Computer Science (1.10.2017), D-INFK, formerly Associate Professor in the same subject area

Professor Sven Panke,
Bioprocess Engineering (1.10.2017), D-BSSE, formerly Associate Professor in the same subject area

Professor Marco Stampanoni,
X-ray Imaging (1.10.2017), D-ITET, formerly Associate Professor in the same subject area

ASSOCIATE PROFESSORS

New appointments

Professor Arno Brandlhuber,
Architecture and Design (1.8.2017), D-ARCH, formerly Professor at the Academy of Fine Arts in Nuremberg, Germany

Professor Eleni Chatzi,
Structural Mechanics (1.4.2017), D-BAUG, formerly Assistant Professor (tenure track) at ETH Zurich, Switzerland

Professor Jan De Vylder,
Architecture and Design (1.8.2017), D-ARCH, formerly Professor at KU Leuven, Belgium

Professor Christian Degen,
Spin Physics (1.4.2017), D-PHYS, formerly Assistant Professor (tenure track) at ETH Zurich, Switzerland

Professor An Fonteyne,
Architecture and Design (1.8.2017), D-ARCH, formerly Professor at Hasselt University, Belgium

Professor Dominik Hangartner,
Public Policy (1.8.2017), D-GESS, formerly Associate Professor at London School of Economics and Political Science, United Kingdom

Professor Torsten Hoefler,
Scalable Parallel Computing (1.6.2017), D-INFK, formerly Assistant Professor (tenure track) at ETH Zurich, Switzerland

Professor Jonathan Home,
Experimental Quantum Information (1.1.2017), D-PHYS, formerly Assistant Professor (tenure track) at ETH Zurich, Switzerland

Professor Steven Johnson,
Physics (1.8.2017), D-PHYS, formerly Assistant Professor (tenure track) at ETH Zurich, Switzerland

Professor Momoyo Kaijima,
Architectural Behaviorology (1.8.2017), D-ARCH, formerly Associate Professor at the University of Tsukuba, Japan

ASSISTANT PROFESSORS

New appointments

Professor Maksym Kovalenko,
Inorganic Functional Materials (1.1.2017), D-CHAB, formerly Assistant Professor (tenure track) at ETH Zurich, Switzerland

Professor Anne Lacaton,
Architecture and Design (1.9.2017), D-ARCH, joint owner of Lacaton & Vassal architectural practice, France

Professor Paola Picotti,
Molecular Systems Biology (1.10.2017), D-BIOL, formerly Assistant Professor at ETH Zurich, Switzerland

Professor Tanja Stadler,
Computational Evolution (1.10.2017), D-BSSE, formerly Assistant Professor (tenure track) at ETH Zurich, Switzerland

Professor Martin Vechev,
Computer Science (1.8.2017), D-INFK, formerly Assistant Professor (tenure track) at ETH Zurich, Switzerland

Professor Marcy Zenobi-Wong,
Tissue Engineering and Biofabrication (1.6.2017), D-HEST, formerly Assistant Professor (tenure track) at ETH Zurich, Switzerland

Professor Ueli Angst,
Durability of Engineering Materials (1.1.2017), D-BAUG, formerly postdoctoral researcher and lecturer at ETH Zurich, Switzerland

Professor Johannes Bohacek,
Molecular Neuroscience and Behavioural Research (1.7.2017), D-HEST, formerly senior assistant at the University of Zurich, Switzerland

Professor Francesco Corman,
Transport Systems (1.8.2017), D-BAUG, formerly senior scientist at IBM Nederland BV in Amsterdam, Netherlands

Professor Stelian Coros,
Computational Robotics (1.8.2017), D-INFK, formerly Assistant Professor (tenure track) at Carnegie Mellon University, Pittsburgh, USA

Professor Thomas Ward Crowther,
Global Ecosystem Ecology (1.10.2017), D-USYS, formerly postdoctoral researcher at the Netherlands Institute of Ecology, Wageningen, Netherlands

Professor Daniela Domeisen,
Atmospheric Predictability (1.8.2017), D-USYS, formerly Junior Professor at GEOMAR Helmholtz Centre for Ocean Research Kiel, Germany

Professor Stefan Feuerriegel,
Management Information Systems (1.10.2017), D-MTEC, formerly research group leader at the University of Freiburg, Germany

Professor Stefanie Jonas,
RNA Biology and Disease (1.8.2017), D-BIOL, formerly postdoctoral researcher at ETH Zurich, Switzerland

Professor Johan Lilliestam,
Renewable Energy Policy (1.8.2017), D-USYS, formerly senior researcher at ETH Zurich, Switzerland

Professor Hubert Pausch,
Animal Genomics (1.5.2017), D-USYS, formerly research assistant at the Technical University of Munich, Germany

Professor Joshua Payne,
Computational Biology (1.9.2017), D-USYS, formerly group leader at the University of Zurich, Switzerland

Professor Christian Schöb,
Agricultural Ecology (1.7.2017), D-USYS, formerly group leader at the University of Zurich, Switzerland

Professor Simone Schürle,
Responsive Biomedical Systems (1.8.2017), D-HEST, formerly postdoctoral researcher at the Massachusetts Institute of Technology, Cambridge, United States of America

Professor David Steurer,
Theoretical Computer Science (1.8.2017), D-INFK, formerly Assistant Professor at Cornell University, Ithaca, United States of America

Professor Vincent Tassion,
Mathematics (1.1.2017), D-MATH, formerly postdoctoral researcher at the University of Geneva, Switzerland

Professor Mark Tibbitt,
Macromolecular Engineering (1.6.2017), D-MAVT, formerly postdoctoral researcher at the Massachusetts Institute of Technology, Cambridge, United States of America

ADJUNCT PROFESSORS

Professor Mark Mescher,
D-USYS, senior scientist at ETH Zurich, Switzerland

Professor Claude Ederer,
D-MATL, senior scientist and lecturer at ETH Zurich, Switzerland

Professor Aude Gehrmann-De Ridder,
D-PHYS, senior scientist and lecturer at ETH Zurich, Switzerland

Professor Vadim Geshkenbein,
D-PHYS, senior scientist and *Privatdozent* at ETH Zurich, Switzerland

Professor Robert Grass,
D-CHAB, senior scientist and lecturer at ETH Zurich, Switzerland

Professor Alexey Kuvshinov,
D-ERDW, senior scientist and *Privatdozent* at ETH Zurich, Switzerland

Professor Roland Regös,
D-USYS, research group leader and *Privatdozent* at ETH Zurich, Switzerland

For department name abbreviations, visit
www.ethz.ch/departments

AGROVET-STRICKHOF OFFICIALLY OPENED

New alliances in agricultural research and practice

In September 2017, ETH Zurich, the University of Zurich and the canton of Zurich opened AgroVet-Strickhof in Lindau. The state-of-the-art facilities allow ETH professorships to conduct interdisciplinary research with direct links to agricultural practice.

At the Agrovet-Strickhof site in Lindau, near Zurich, a series of new buildings with state-of-the art facilities have been constructed in recent years.

At AgroVet-Strickhof, scientists will investigate the entire value chain, from feed production to the animal to the foodstuff. "From feed to food" describes this holistic approach. During the opening ceremony in Lindau (ZH), ETH President Lino Guzzella emphasised: "Interdisciplinarity is one of the most important keys to innovation."

Of particular importance for ETH is the metabolic centre, equipped with respiratory chambers for large and small animals and a metabolic shed, which researchers will use to study the foundations of efficient and environmentally friendly livestock systems. On the ETH side, three professors from the Institute of Agricultural Sciences will be particularly active at the new facilities.

For Michael Kreuzer, Professor of Animal Nutrition, the major added value of AgroVet-Strickhof lies in the close connection between fundamental and application-oriented research. "This allows inspirational ideas to flow in both directions," he says. His group is investigating whether milk and milk products differ in quality if the cows eat hay instead of silage.

Susanne Ulbrich, Professor of Animal Physiology, also welcomes the link between research and practice: "It is essential to consider the whole animal during research. The physical proximity of agricultural scientists, veterinary surgeons and people actually working in farming mean we can share ideas continually and at many different levels."

Hubert Pausch, Professor of Animal Genomics, says that the facilities will allow him to measure characteristics of individual animals precisely and draw conclusions about the function of specific positions in the genome. "For me, though, feedback from livestock keepers who see the animals every day is just as important as exchanging ideas with other scientists."

Besides the main site at Lindau, the AgroVet-Strickhof collaboration also includes operations at Früebüel in the canton of Zug and Alp Weissenstein in the canton of Graubünden. This allows projects to be conducted at different altitudes. ■

Plenty of room for interdisciplinary research: the dairy barn can accommodate 128 cows.

www.agrovet.zh.ch

The ETH Campus Hönggerberg 2040 master plan: a compact design makes for an attractive campus.

CITY CENTRE AND HÖNGGERBERG SITES

Important milestones reached

ETH Zurich's core mission is to deliver attractive teaching, cutting-edge research and the transfer of knowledge. These requirements shape the university's long-term real estate planning and its need for buildings. In the Zurich area, ETH Zurich is focusing its future spatial and structural development on two main locations: Zurich Zentrum (nine departments) and Hönggerberg (seven departments).

Historical structures in the old quarter limit the development opportunities for ETH Zurich in the city centre. Most of the new development will therefore be on the Hönggerberg campus. The ETH Campus Hönggerberg 2040 master plan aims to concentrate development within the current boundaries. The goal is an attractive campus with facilities for teaching, research and leisure. The density and height of campus buildings will conform to urban planning principles, including functioning transport solutions and outdoor spaces but without encroaching on the surrounding landscape. The Hönggerberg campus will have reached the permitted construction limit once the laboratory and office building planned for the Department of Physics is completed. All planning works are therefore being revised so as to be able to extend the campus as ETH Zurich grows. The relevant planning application was submitted to the cantonal parliament in the autumn of 2017. Special building regulations for the city of Zurich with mobility and open-space concepts were presented to the public in spring 2018. They will be adopted by the city council and city parliament in 2019.

In the Zurich City University District, ETH completed the groundworks for the new GLC building in 2017. GLC will include facilities for teaching, research and the application of medical technology. In addition, the planning principles of the university district have been agreed and an urban space concept has been formulated for unused and exterior spaces. ■

PIZ DAINT SUPERCOMPUTER

Fastest computer outside Asia

The Piz Daint supercomputer at the Swiss National Supercomputing Centre (CSCS) in Lugano is the most powerful mainframe computer outside Asia. An extensive hardware upgrade at the end of 2016 more than tripled its performance. With a theoretical peak performance of 25.3 petaflops, it offers a key platform for pioneering research in Switzerland and Europe. It is also one of the world's most energy-efficient mainframe computers. The system is based on a Cray XC40/XC50. Powerful computers such as Piz Daint are crucial for high-resolution computer-intensive simulations, such as those used in climate and material research, or in the life sciences. ■

www.cscs.ch

FACULTY RETREAT

ETH+ initiative launched

November's Faculty Retreat in Lucerne provided an ideal platform for the Executive Board and faculty members to discuss the university's future direction. Talks focused on the Executive Board's proposal for a significant increase in the number of professorships.

What is the ideal strategic, organisational and personnel configuration to ensure ETH's continuing national and international success? How can the university maintain its strong standing within Switzerland to secure the generous support it receives politically and from Swiss society as a whole? How can ETH professors promote the culture of effective and responsible leadership?

Finding answers to these questions was the main purpose of the Faculty Retreat held on 10 and 11 November in Lucerne, where around 270 assistant, associate and full professors, along with the heads of the central administrative units, discussed many other fundamental issues, under the moderation of Gerd Folkers, Head of the Critical Thinking Initiative. Particular attention was given to a proposal put forward by ETH President Lino Guzzella: ETH+. This initiative aims to develop ideas to create new opportunities for research, teaching and operations in cutting-edge fields.

President Guzzella cautioned that although ETH Zurich's output was widely acknowledged to be consistently outstanding, it must invest more in high-calibre talents if it is to remain a driving force for Switzerland and Swiss innovation, as well as maintaining its international reputation for excellence. One of the goals of ETH+ is to improve the staff-student ratio so as to make teaching and supervision more flexible and effective.

The Executive Board has initiated a process to finalise the project working in conjunction with the ETH faculty and consultative committees. To finance this new expansion phase, it plans to use the funds that the entire university has saved through prudent long-term financial planning. ■

She keeps the university running smoothly: in her role as ETH Zurich Secretary General, **Katharina Poiger** supports the Executive Board and the President and helps to ensure that the ideas and needs in respect of teaching, research and knowledge transfer are efficiently implemented on both an organisational and administrative level. She coordinates the operations of the Executive Board and the Conference of the Heads of Department. She also liaises with the ETH Board and the institutions in the ETH Domain, as well as with swissuniversities, the higher education policy body that represents Swiss universities, universities of applied sciences and universities of teacher education. For Poiger, it is precisely these cross-university perspectives that make her role so exciting.

Governance and sustainability

With the Executive Board chaired by the ETH President and a solid system of participation, ETH Zurich has a sound leadership structure that has played a key role in delivering successful outcomes for the university. A well-established risk management system also makes a vital contribution to our institution's long-term development. Risk management at ETH Zurich takes account of potential internal as well as external risks, and is guided by internationally established standards. Risks are continuously analysed and controlled as part of a systematic process – especially those which could potentially harm the university's reputation. Appropriate measures are in place to increase risk awareness at ETH Zurich and reduce risk exposure to an acceptable minimum.

ETH Zurich is one of the world's leading universities in energy, environmental and sustainability research. This is due in no small part to its decision 30 years ago to establish a dedicated department for environmental sciences – the first of its kind at a European university – and thus lay the foundation for the university's long-term commitment in this field. As a leading institution in this area, ETH today integrates the principles of sustainable development in its research and teaching activities, as well as in the campus and its dialogue with society.

ETH Zurich governance

Optimal organisational structure

ETH Zurich's characteristic leadership structure combines a distinctly presidential system with broad participation rights. This style of governance typifies the ETH culture.

The ETH President carries overall responsibility, specifically in the fields of strategy and finance, and nominates vice presidents of the Executive Board as well as professors. This is counterbalanced by a well-established system of participation, which guarantees the robustness and broad acceptance of the decisions taken, as a quality-assurance check across the whole institution. Within this broad-based decision-making process, it is not only the Executive Board that plays a central role, but also the academic departments, which bring together the members of ETH Zurich who work in a specific scientific field, as well as the University Assembly. Based on the principle of equal representation, the Assembly is made up of elected representatives from all four groups of university members: lecturers, scientific staff, students, and administrative and technical staff.

Executive Board

The Executive Board is the principal governing body of ETH Zurich. It is made up of the President, Rector (Vice President for Education, nominated by the professors), Vice President for Research and Corporate Relations, Vice President for Finance and Controlling, and Vice President for Human Resources and Infrastructure. The Executive Board ensures that the university fulfils its social and economic responsibilities. It meets twice a month and is responsible for enacting study programme regulations, establishing or closing down departments and other units, such as interdepartmental centres of excellence, and for ensuring the overall quality of the institution. To this end, it carries out regular departmental evaluations, among other things. The President also consults with the Executive Board on all matters relating to strategy and finance.

The Executive Board is supported in its decision-making by a number of advisory committees, namely in the fields of strategy, teaching and research. The Rector is supported in her area of responsibility by vice rectors, while the President draws on the support of various delegates with special tasks assigned to them. Ombudspersons, or trusted intermediaries in the case of research-specific disputes, provide ETH members with advice and support when conflicts occur.

Academic departments

The academic departments are responsible for their own strategic planning, running their degree courses and coordinating their research. In addition to this, several departments provide teaching services for degree courses run by other departments. This is because, for reasons of quality, the teaching of foundation science subjects is undertaken by the respective department for all students across the entire university. The President distributes funds to the departments each year to finance this provision, which the departments manage autonomously. In doing so, the departments ensure an appropriate provision of professorships as the fundamental operating unit of ETH Zurich, within the context of ETH's culture of empowerment.

The principal authority within each academic department is the Department Conference. It includes all professors and representatives of the remaining teaching staff within the department, as well as representatives of the scientific staff, students, and administrative and technical staff. It meets at least twice every semester, and is responsible for planning and defining the scope of professorships for approval by the President, preparing study programme regulations for approval by the Executive Board, nominating department heads for approval by the President, and electing directors of studies. The Professors' Conference, which includes all professors, makes proposals to the President regarding the promotion of professors and the awarding of professorial titles.

Study programme regulations are decided on by the respective department conference and approved by the Executive Board. They are drawn up by the Teaching Commission of the individual department, which is made up of representatives of the faculty, scientific staff, and students according to the principle of equal representation. In other words, at the departmental level, particularly in relation to curriculum development and course design, the system of participation that defines ETH becomes one of comprehensive co-determination.

Interaction between Executive Board and academic departments

The institutional dialogue between the Executive Board and the academic departments takes place through the Conference of the Heads of Department and the Conference of the Directors of Study, as well as through dialogue between departmental management and the Executive Board. The Conference of the Heads of Department, which comprises heads of department and members of the Executive Board, meets once a month. It concerns itself with overarching questions relating to strategy and planning, teaching and research. It serves the interests of mutual information exchange and the establishment of best practice. At the Conference of the Directors of Study, led by the Rector, the directors of study at departmental level address questions concerning study programmes and examinations. Annual dialogues between the Executive Board and departmental management teams ensure that the success of each department is monitored, and departmental planning – especially in relation to professorships – kept up to date.

Flexibility breeds success
ETH Zurich has consciously opted for a flexible departmental structure with heads of department actively involved in science. This ensures diversity and the scope for development necessary for long-term scientific success. Because the Executive Board has the freedom to change the university's organisational structure, ETH Zurich can quickly adapt the Executive Board and the university's departments to take account of altered circumstances.

Organisation chart 2017

As of 31 December 2017

Ombudspersons | **University Assembly**

Executive Board and administration

Executive Board and General Secretariat	**President** **Professor Lino Guzzella**				
	Rector **Professor Sarah Springman**	**Vice President for Research and Corporate Relations** **Professor Detlef Günther**	**Vice President for Finance and Controlling** **Dr Robert Perich**	**Vice President for Human Resources and Infrastructure** **Professor Ulrich Weidmann**	**Secretary General** **Katharina Poiger Ruloff**
Vice Rectors (VR) and Associate Vice Presidents (AVP)	AVPs for: – ETH Global – Equal Opportunities – Sustainability – Digital Transformation	VRs for: – Study Programmes – Curriculum Development – Doctoral Studies – Continuing Education			
Staff units	– President's Staff – Office for Faculty Affairs – ETH Global – ETH Sustainability – Strategic Development	– Rector's Staff	– Office of Research – EU GrantsAccess – ETH transfer		– Office of Resources	– Legal Office
Administrative departments	– Corporate Communications	– Academic Services – Student Services – Educational Development & Technology		– Controlling – Accounting – Financial Services	– Human Resources – Real Estate Management – Facility Management – IT Services – ETH Library – Services – Safety, Security, Health and Environment	

Academic departments

Architecture and Civil Engineering	Engineering Sciences	Natural Sciences and Mathematics	System-oriented Natural Sciences	Management and Social Sciences
Architecture	**Mechanical and Process Engineering**	**Mathematics**	**Earth Sciences**	**Management, Technology and Economics**
Civil, Environmental and Geomatic Engineering	**Information Technology and Electrical Engineering**	**Physics**	**Environmental Systems Science**	**Humanities, Social and Political Sciences**
	Computer Science	**Chemistry and Applied Biosciences**	**Health Sciences and Technology**	
	Materials	**Biology**		
	Biosystems Science and Engineering			

For teaching and research facilities outside the departments see: **www.ethz.ch/organisation-en**

ETH Zurich Executive Board 2017

As of 31 December 2017

Detlef Günther (1963) has been Assistant Professor (since October 1998), Associate Professor (since 2003) and Full Professor (since February 2008) of Trace Element and Microanalysis at the Laboratory of Inorganic Chemistry at ETH Zurich. Since January 2015 he has served as Vice President for Research and Corporate Relations at ETH Zurich.

Sarah Springman (1956) has been Full Professor of Geotechnical Engineering at ETH Zurich since January 1997, heading the institute from 2001 to 2005 and again from 2009 to 2011. She also served as Joint Deputy Head of the Department of Civil, Environmental and Geomatic Engineering from 2013 to 2014. Since January 2015 she has been Rector of the university and acts as deputy to the ETH President.

Lino Guzzella (1957) was appointed Assistant Professor at ETH's Department of Mechanical and Process Engineering in 1993. Before that he worked in industry, as Sulzer's R&D group head and as head of the mechatronics department at Hilti. In 1999 he was appointed Full Professor for Thermatronics. From August 2012 to December 2014 Guzzella was Rector of ETH Zurich, and has been President of the university since January 2015.

Robert Perich (1961), who has a doctorate in business administration, has been Head of the Finance and Controlling division at ETH Zurich since 2003 and Vice President for Finance and Controlling since October 2008. Before that, he worked for 11 years in the financial services industry, most recently as CFO and Member of the Executive Board of the Private Banking Switzerland division of a leading Swiss bank.

Ulrich Weidmann (1963) has been Full Professor of Transport Systems at ETH Zurich since June 2004, and also served as Head of the Department of Civil, Environmental and Geomatic Engineering from 2013 to 2015. He became Vice President for Human Resources and Infrastructure in January 2016. He held various senior management roles with the Swiss Federal Railways (SBB) from 1994 to 2004.

Remuneration

In 2017, the salaries of the five members of the Executive Board, including the employer's social security contributions, came to CHF 2.08 million (last year: CHF 2.09 million). The total sum includes CHF 0.35 million (last year CHF 0.35 million) for pension benefits and CHF 0.12 million for other social security contributions (last year CHF 0.12 million).

Secondary employment

Lino Guzzella: Member of the Board of Directors of Kistler Holding Ltd., shareholder of Robert Bosch Industrietreuhand KG (RBIK), Member of the Senate of the Max Planck Society, Member of SUSTech International Advisory Council

Sarah Springman: Board Member of UK Sport

Detlef Günther: Member of the Board of Directors of GRS GemResearch Swisslab AG

Robert Perich: none

Ulrich Weidmann: Member of the Board of Directors: VBG Verkehrsbetriebe Glattal AG, Auto AG Schwyz. Member of the Arbitration Panel: Gotthard Base Tunnel (Rail Technology), Ceneri Base Tunnel (Rail Technology and Overall Coordination, Railtrack and Logistics). Trustee of the Board: Fachstelle für behindertengerechtes Bauen (buildings for people with disabilities).

Risk management

Systematic process

Risk management at ETH Zurich covers the entire institution, and takes account of both internal and external potential risks. ETH's risk management process takes its lead from ISO 31000, the internationally recognised risk management standard. Risks are continually identified, analysed, documented and controlled as part of a systematic process. This holistic approach also takes account of compliance, environmental and procurement risks. The goal of risk management at ETH Zurich is the safeguarding of tangible and intangible assets – assets which determine the success of the university. In particular, they include human capital, infrastructure and ETH's reputation.

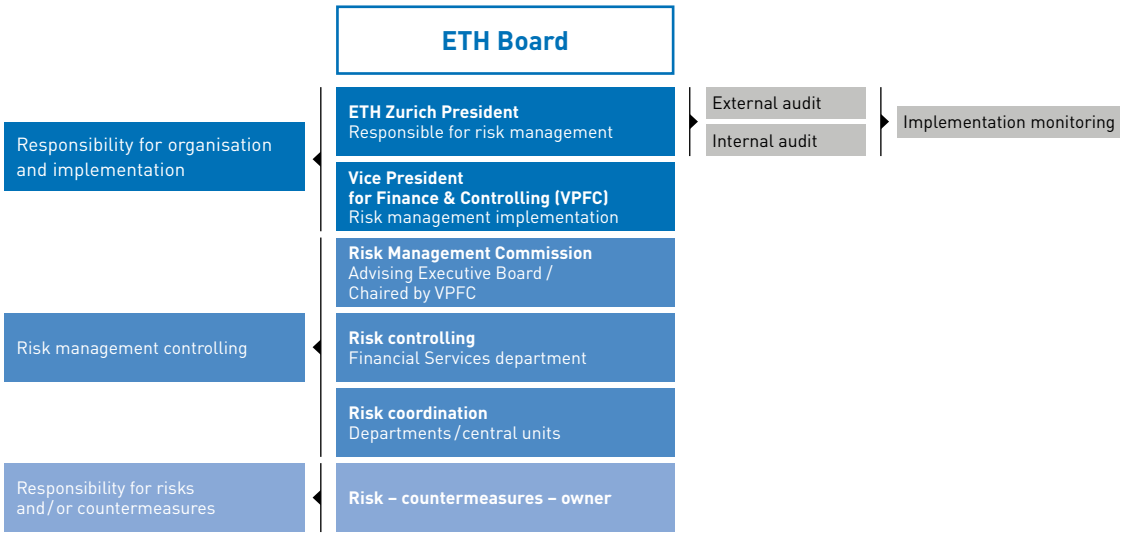
Legal foundations and governance
The Swiss ETH Act grants autonomy to each of the ETH Domain's six institutions, which in turn forms the bedrock of their work in the fields of teaching, research and service provision. Each institution is itself responsible for managing risk within its own sphere of operations, and reports regularly to the ETH Board in its role as the university's supervisory body. The essential parameters of risk management and risk financing at ETH Zurich are laid down in the ETH Board's directive of 4 July 2006 on risk management within the ETH Domain.

As the officeholder with overall responsibility for risk management at ETH Zurich, the ETH President informs the ETH Board on an annual basis in relation to its core risks, in particular the scope and extent of those risks, their potential impacts on the institution, as well as any countermeasures already planned and implemented. The President also informs the ETH Board without delay of any exceptional changes to the risk profile or any instances of loss or damage.

Organisation and process
Whereas the President has overall accountability for risk management, responsibility for implementation lies with the Vice President for Finance and Controlling. The latter chairs the Risk Management Commission, which advises the President and the Executive Board in all matters concerning risk management, risk financing and insurance. The Commission decides what action to take in relation to risk reporting and assessment, risk minimisation and controlling, while overseeing the process as a whole.

The Executive Board is informed regularly about any substantive risks and their possible impacts, and on the progress of any countermeasures aimed at avoiding and mitigating risk. ETH Zurich has nominated an officer responsible for each core risk. Appropriate measures are in place to ensure that risk potential at the university is reduced to an acceptable minimum. Finally, if ETH Zurich's risk capacity is exceeded, insurance policies are in place to cushion that risk.

Internal control system (ICS)
An important instrument in relation to risk management is an internal control system (ICS), which evaluates relevant financial processes and corresponding risks associated with bookkeeping and accounting, and minimises those risks through appropriate control measures. The ICS encompasses those procedures and measures that ensure accurate bookkeeping and accounting, which in turn form the basis of sound financial reporting. The Swiss Federal Audit Office verifies the existence of the ICS in the context of its statutory audit.



Core risks

Risks with potentially major impacts on finances or reputation are designated as core risks.

- ETH Zurich's highly educated lecturers, researchers, students and support staff (its human capital) are a key factor for its success. The risk that persistent and structural factors could diminish this human capital is therefore weighted correspondingly highly.

- A significant **loss of financial resources** due to a reduction in federal funding or a drop in third-party contributions would have immediate consequences for the quality and quantity of ETH's teaching and research, and therefore represents a correspondingly high level of risk.

- ETH Zurich is tasked with providing education at the highest level. A severe deterioration in the quality of teaching due to **changes in education policy or resource adjustments** would represent a reputational risk. A shift in priorities in the field of education policy, followed by declining financial resources, would lead to a drop in the quality of teaching, falling student numbers and a decline in new academic talent.

- **Research integrity** is a key prerequisite for scientific success. Disregarding this principle can lead to data manipulation, plagiarism, dereliction of duties of care, non-disclosure of conflicts of interest, and violations of, or non-adherence to, applicable ethical standards. This can make it impossible to guarantee the integrity of research findings. A work group charged with implementing the key principles of good scientific practice creates the necessary foundation for ensuring that research integrity is continuously adapted to accommodate the changing requirements associated with scientific progress.

- ETH Zurich's business processes are reliant on a fully functioning data network and secure data storage media. A **loss of data or a network failure** presents considerable risks to ETH's business processes, as does unauthorised access to its data. Measures implemented to achieve the protection targets defined as part of IT security are regularly reviewed by a panel of technical experts and adjusted as necessary.

- The Swiss Federal Act on Public Procurement and the associated Ordinance govern the principles of **procurement.** A risk may emerge due to a compliance infringement in the procurement process. An effective procurement organisation ensures that federal procurement laws are adhered to and the goods and services purchased satisfy ETH Zurich's economic and environmental criteria.

- Rapid and open **communication** regarding the core tasks of research, teaching and technology transfer, as well as the management of ETH Zurich, serves to strengthen trust and relationships with stakeholders and promotes the reputation of ETH Zurich, both nationally and internationally. Failures of communication by ETH Zurich could lead to a loss of credibility and acceptance, incurring a loss of trust among key stakeholders. This would have corresponding financial and personnel impacts.

- **Violence or threats against the person** are the result of a complex interplay of factors operating on several levels. Violence is not limited to actual physical aggression, but also manifests itself in threats of violence, abuse of power and sexual harassment. Through preventive measures and constant reassessment of the current level of threat based on standardised instruments, the ETH Threat Management Team diffuses problems and conflicts at an early stage, before they escalate into violence.

- **Large-scale damage to the real estate used by ETH Zurich but owned by the Swiss Confederation** entails the risk that the infrastructure necessary for research, teaching and the management of ETH Zurich may be unavailable for an extended period, resulting in the cancellation of important research and teaching activities in whole or in part. Measures to safeguard and increase the safety of buildings are an integral part of every newbuild or modernisation project, with the aim of averting major incidents.

Greater use of business impact analyses (BIA) for ETH Zurich's critical infrastructure
A business impact analysis identifies the potential consequences of a loss of business-critical functions for an organisation. Here an assessment is made of the critical resources, maximum tolerable downtimes and the highest bearable loss. The business continuity management plan takes the results of the BIA and puts strategies in place to ensure that services can be restored within the timeframe specified as tolerable downtime.

Sustainability in practice

A long tradition of sustainability

Thirty years ago, ETH Zurich was the first university in Europe to establish a department dedicated to environmental sciences. This laid the foundation for a long-term commitment. Today it is an international centre of excellence and a benchmark for sustainability research, incorporating the principles of sustainable development in the core areas of research, teaching, campus, and its dialogue with society.

ETH Zurich places sustainability at the highest level of the decision-making process, with the Sustainability Office reporting directly to the President. It is a strategic objective to maintain and expand the university's excellent international reputation in the fields of environmental, climate, and nutrition research. As well as activities carried out within departments, ETH defines thematic priorities that allow dynamic cooperation across disciplines.

Four fields of action on sustainability
In research and teaching, on campus and in dialogue with society, ETH Zurich is a trendsetter when it comes to sustainability. For each of these four key areas, it defines a field of action:

1 **Research:** Through its basic and applied research, and with a growing number of research centres of excellence, ETH furnishes the know-how required for a sustainable society. Its approach is focused on the themes of energy, nutrition, climate, cities of the future, and risk.

2 **Education:** ETH trains future generations of scientists who will be committed to sustainable development. As an example, 180 students took part in ETH Week 2017: Manufacturing the Future. Others attended the ETH Sustainability Summer School 2017, a nine-day course in the Taminatal in St. Gallen. Thirty-two students from 14 countries and 17 disciplines worked on four interdisciplinary and transdisciplinary case studies relating to Mountain Forests & Risk Management. Besides theoretical inputs on environmental, economic and social aspects as well as practical work, the participants learned about the complex interrelationships of the mountain forest ecosystem.

3 **Campus:** ETH observes sustainability principles on campus as part of daily life. A groundbreaking project is the "anergy" grid on the Hönggerberg campus, which was started in 2013. The system now consists of three underground storage units and four control centres, supplying heat and cold from the ground to ten buildings. In 2017, ETH Zurich received the Platinum label of the Swiss Sustainable Building Council (SGNI) for the renovation of the HIF research building. Also in 2017, the Executive Board gave further impetus to energy research by approving the ETH Zurich Zentrum energy master plan. This is to be realised between 2018 and 2025 and involves replacing the existing, decentralised cooling supply with a new system using lake water, which will supply the university district. This will improve not only energy efficiency but also the reliability of supply.

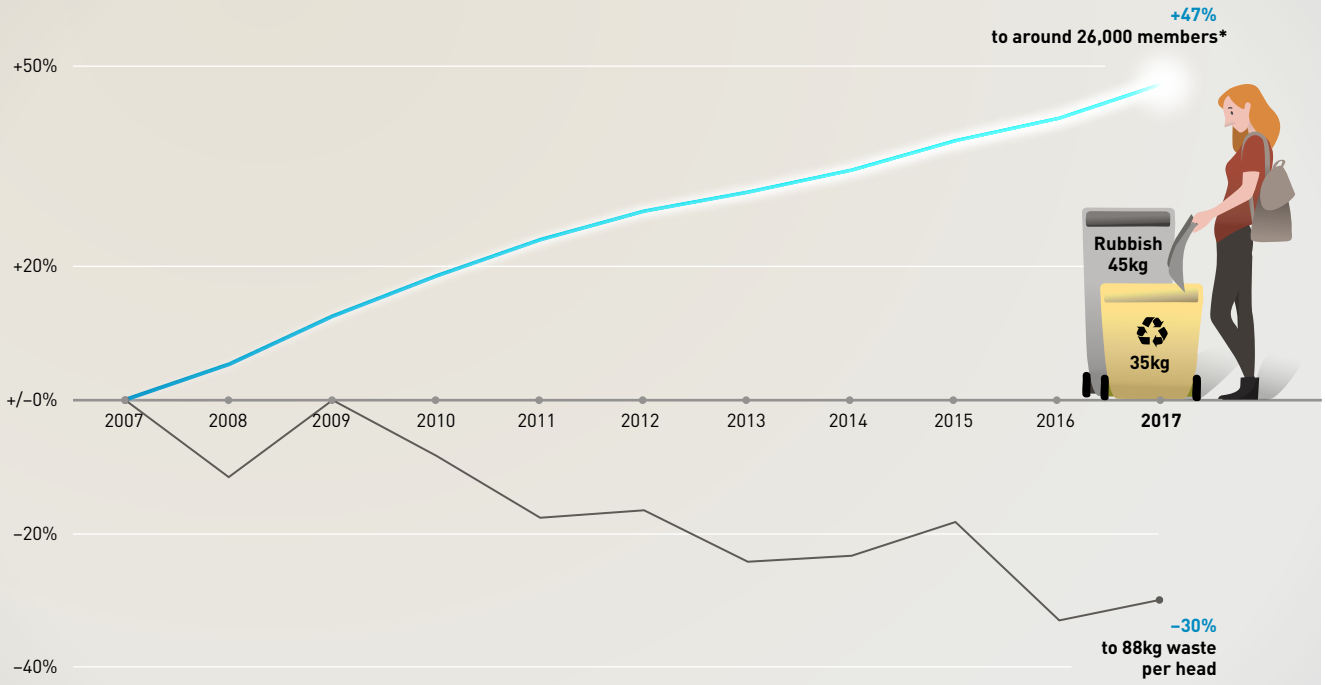
4 **Dialogue:** ETH regularly informs the public about the latest results of its research. A range of offerings, such as Treffpunkt Science City and Scientifica, allow a proactive dialogue with the public. In 2017, a documentary film about ETH Zurich was broadcast by the Arte TV network. *Inventing the Future in Zurich* shows how ETH is tackling some of the world's most pressing problems, and how its scientists are working across many complex fields to create a sustainable future.

Transparency and credibility
ETH Zurich's commitment to sustainable development is also reflected in its reporting. Its energy report, first published in 2002, was developed into a broader environmental report in 2005. Since 2009/2010, the report has included all three areas of sustainability and reports extensively on ecological, economic and social aspects. In 2017, the current sustainability report for 2015/2016 appeared for the first time simultaneously with ETH Zurich's annual report. It deals with each of the four fields of action and provides an insight into developments, successes and challenges. Highlights from the reporting period and around 50 objectives complete the picture. The next sustainability report covers the years 2017/2018 and will appear in the spring of 2019.

ETH Zurich has compiled all its sustainability reports in accordance with the international Global Reporting Initiative (GRI) standard and taking into account the ISCN/GULF Sustainable Campus Charter of the International Sustainable Campus Network (ISCN). These sustainability reports are notable for their high degree of stakeholder involvement, for their local, national, and global impact, and for being certified by external auditors.

www.ethz.ch/sustainability-report
www.ethz.ch/sustainability
www.ethz.ch/environment

ETH members and waste per head since 2007



* FTEs, ETH members – staff (including doctoral students and student employees) and students

Sustainability and mobility at ETH

ETH Zurich is also committed to sustainable mobility. The Mobility Platform launched in 2016 initiated several projects in 2017 to bring about long-term reductions in ETH Zurich's CO_2 emissions generated by air travel and campus mobility.

Work-related travel by ETH staff currently accounts for around 60 percent of ETH's total CO_2 emissions. Some 80 percent of these are caused by long-haul flights. The number of flights taken by students as part of their curriculum more than doubled between 2006 and 2015. To cut flight-related CO_2 emissions, in 2017 the Executive Board decided to launch a participatory process in which each academic department is required to develop its own reduction target for flights taken by staff and students. The departments' proposals will be consolidated in 2018 and implemented in 2019.

Of the total journeys to and from our campus, 80 percent are already made by public transport and 15 percent on foot or by bicycle. Following expansion of the ETH Link shuttle bus service, which carries up to 4,500 passengers per day, the focus in 2017 was on e-bikes. ETH staff took part in a pilot project to try sharing e-bikes amongst specific teams, for example. In view of the positive response, ETH's own 12 e-bikes will become a permanent part of the university's mobility offering. A successful trial was carried out with smide, a private bike-loan system, in which around 100 ETH members were able to use "free-floating" e-bikes.

www.ethz.ch/mobility
www.ethz.ch/airtravel

Anyone interested in the predicted student enrolments at ETH in 2030, or what the much-quoted rankings actually say about our university, has found the right person: **Urs Hugentobler,** 63 years old and Deputy Head of the Controlling department, is the guardian of our data – and much more besides. Together with his colleagues, Hugentobler (originally a plant scientist) has been gathering, preparing and interpreting relevant data in order to support the decision-making processes of the Executive Board and numerous other areas of ETH.

Finance

2017 was another period of sustained growth for ETH Zurich. The number of students increased again, new professors were appointed, and substantial investments were made. Consolidated operating expenses amounted to 1,748 million Swiss francs in total, a 6 percent increase on the previous year. Total consolidated revenue climbed 6 percent to 1,885 million Swiss francs because of the higher operating revenue, the sharp rise in the net finance income and the share of the surplus or deficit of associated entities.

The university's independence is a vital element when competing against other leading international institutions and keeping its place at the top of global rankings. It is therefore important for ETH Zurich to pursue a long-term, sustainable financial policy. This is based on a financial plan covering a period of several years and a long-term approach to balance sheet management. Selective diversification of its sources of funding also helps to keep the university on a sustainable track. The growing volume of third-party funding that the university attracts allows it to implement its strategy more quickly, expand its research activities and expedite planned investments and research projects. In raising this funding, it is vital for ETH Zurich to maintain its freedom in teaching and research as well as its strategic and financial scope. The federal financial contribution (global budget) provides a basis on which to do so.

ETH Zurich's consolidated annual financial statements clearly present the financial position, financial performance and cash flows on an accrual basis. They have been prepared in accordance with International Public Sector Accounting Standards (IPSAS), ETH Zurich being one of the few universities worldwide to undergo a full IPSAS audit.

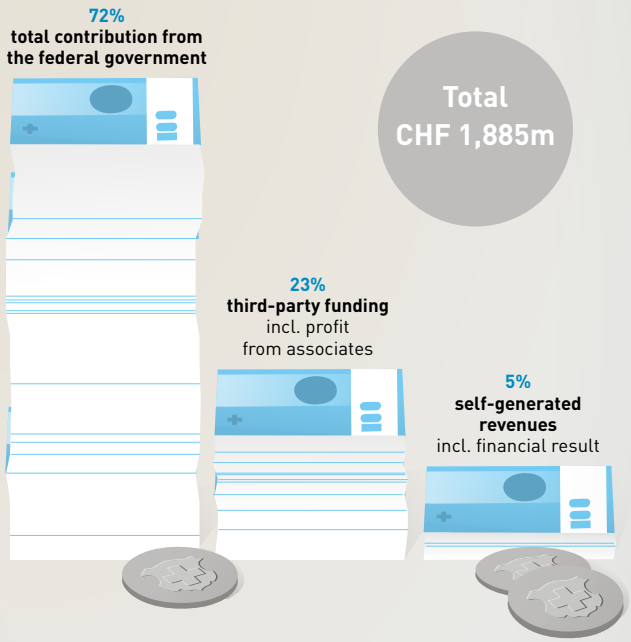
Current developments

The number of students increased by a further 4 percent to 20,607, another new record. Today, the university is educating 56 percent more students than it was ten years ago. Over the same period, ETH Zurich saw 23 percent growth in the number of professors and a 53 percent rise in scientific staff, as well as a 42 percent increase in the federal contribution and just a 7 percent increase in the main usable area. These figures clearly show that ETH Zurich needs to make continual efforts to maintain the high quality of teaching and research. As well as appointing new professors to expand the teaching staff, setting up new research groups also plays a key role in ensuring ETH Zurich is able to deliver on its promise of fostering stellar performances in teaching and research.

These developments are also reflected in the key financial figures. Consolidated operating expenses amounted to 1,748 million Swiss francs in total, a 6 percent increase on the previous year. Total consolidated revenue climbed 6 percent to 1,885 million Swiss francs due to higher operating revenue, the sharp rise in the net finance income and the share of the surplus or deficit of associated entities. In all, 72 percent of the total revenues came from the federal contribution.

To keep the university on a sustainable path, it is extremely important for ETH Zurich to diversify its funding base. By operating a rigorous quality policy and implementing relevant rules and procedures, ETH Zurich ensures that it manages third-party funding in a responsible and transparent manner.

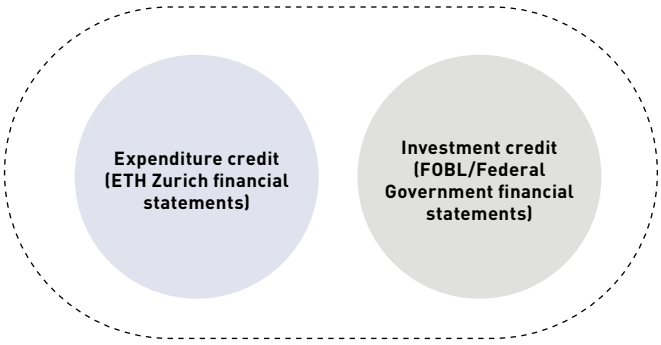
Composition of total revenue (2017)



Federal financial contribution (global budget), sources and use of funds

At a political level, the ETH Domain is managed through the performance mandate, the term and content of which are tailored to the Federal Government-approved funding. The ETH Board allocates the funds to the two Federal Institutes of Technology and the four research institutions under target agreements derived from the performance mandate. The federal financial contribution granted to ETH Zurich (global budget) covers basic teaching and research facilities, as well as its share of building investments for the Federal Government-owned property used by ETH Zurich.

Federal financial contribution (global budget)



With few exceptions, the real estate used by the ETH Domain is owned by the Federal Government and managed within the central Federal Administration by the Federal Office for Buildings and Logistics (FOBL). The ETH Domain and its institutions have been granted extensive powers of delegation and full management responsibility in the development and management of the property portfolio. In its capacity as the Federal Building and Property Service, the ETH Board coordinates the management of the real estate in accordance with the ETH Act and ensures that its value and functionality are maintained. ETH Zurich assumes tasks and responsibilities for the property (owned by the Federal Government or itself) that it manages and uses.

The integral view shown in this section reflects the full delegation of responsibility. It compares the entire mandate performed by ETH Zurich, including property management, with the total federal financial contribution (global budget).

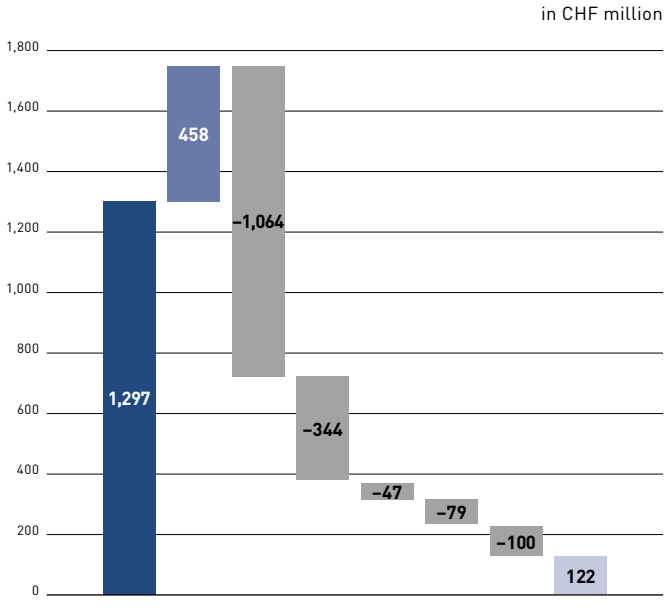
In 2017, the share of the total federal financial contribution (global budget) granted to ETH Zurich by the ETH Board amounted to 1,297 million Swiss francs. In the course of planning and budgeting, the share of the building shell (new buildings, renovations) is separated and recognised as an "investment credit" at the Federal Office for Buildings and Logistics (FOBL). The remainder is entered in ETH Zurich's financial statements as an "expenditure credit" or federal financial contribution (in the narrower sense). The table below shows the breakdown for the last two years:

Global budget (CHF million)

	2017	2016	Absolute change
Federal financial contribution	**1,297**	**1,247**	**50**
Of which, expenditure credit (ETH Zurich)	1,201	1,128	73
Of which, investment credit (FOBL/Federal Government)	96	119	–23

ETH Zurich received third-party funding amounting to 458 million Swiss francs in 2017, primarily from project-oriented research contributions, grants and self-generated revenues. ETH Zurich's total income amounted to 1,756 million Swiss francs.

Composition and use of income (CHF 1,756 million)



- Global budget 1,297
- Third-party funding (consolidated) 458
- **Use (consolidated)**
  Personnel expenditure –1,064
  Other operating expenditure excl. construction spending (not capitalised) –344
  Construction spending (not capitalised) –47
  Investments excl. property, (capitalised) –79
  Construction investments incl. leasehold improvements (capitalised) –100
- Total result (consolidated)[1] 122

The available funds are used, firstly, to cover personnel expenditure for teaching, research and administration and, secondly, for construction spending, other operating expenditure and investments in movable assets. This produced a consolidated total result of 122 million Swiss francs. Third-party funding not used immediately in 2017 was added to financial assets.

In 2017, construction spending on properties amounted to a total of 147 million Swiss francs and was financed through the investment credit (96 million Swiss francs), the expenditure credit (50 million Swiss francs) and third-party funding (1 million Swiss francs).

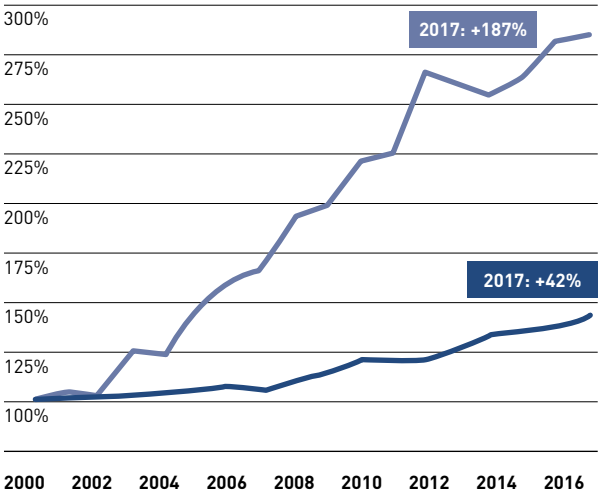
The extensive and varied property portfolio managed by ETH Zurich essentially comprises a large number of dedicated teaching and research buildings designed with their particular purpose in mind and fitted out to suit their specific teaching and research requirements. In total, it contains 178 buildings and facilities, and 70 plots of land. The carrying amount of the plots of land was 691 million Swiss francs at the end of 2017. The buildings were stated in the accounts at a value of 1,430 million Swiss francs at the end of 2017 and their replacement cost (gross cost) was estimated to be 3,550 million Swiss francs.

[1] The total result (consolidated 122 million Swiss francs) is 15 million Swiss francs lower than the annual result according to IPSAS (137 million Swiss francs) due to specific accounting regulations (mainly revenues on an accrual basis, effects of IPSAS 39 and results from associated entities).

Selective diversification makes for a sustainable funding base

The Federal Government is a reliable partner to the university, granting the federal financial contribution (global budget) that ensures ETH Zurich has a solid source of funding. The share of third-party funding rose from 15 percent in 2000 to 26 percent in 2017 and illustrates its increasing importance. Given the strong international competition among universities conducting high-quality, technology-intensive research and the steady rise in student numbers, ETH Zurich faces both the necessity and the growing challenge of consciously diversifying its funding base.

Development of ETH Zurich income structure
(2000 = 100%)



On average over the last five years, around 70 percent of all third-party funding has come from competitive research funding projects. In 2017, just over 150 million Swiss francs came from national research funding organisations such as the Swiss National Science Foundation (SNSF) or Innosuisse (known until the end of 2017 as the Commission for Technology and Innovation, CTI), around 60 million Swiss francs from EU Framework Programmes (Horizon 2020) and just under 50 million Swiss francs from collaborations with industry. A further 60 million Swiss francs came from projects with the Federal Government (special funding of applied research), cantons and local authorities, as well as various international organisations.

Grants (donations, legacies/bequests) made up around 11 percent of third-party funding on average over the last five years. These enable ETH Zurich to implement strategic projects faster and rapidly develop new subject areas in research and teaching, including the necessary infrastructure. By far the largest share of the grants comes through the ETH Zurich Foundation, which acts as an intermediary between donors and ETH Zurich.

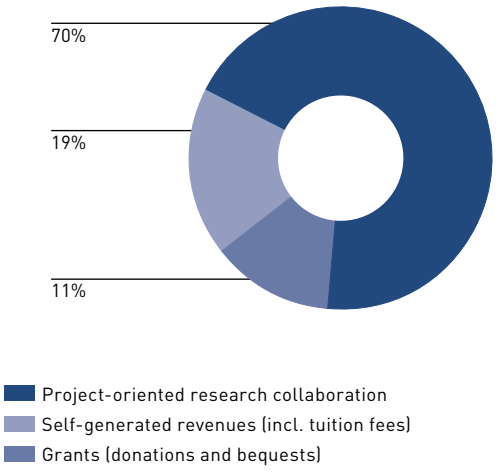
Finally, about 19 percent of the third-party funding was attributable to self-generated revenues. These comprise tuition fees (including various utilisation fees), various items of service revenue and other revenue.

It is vital for ETH Zurich to manage third-party funding responsibly and in conformity with its strategy. First and foremost, it needs to maintain its independence in teaching and research. Defined guidelines with clearly communicated principles (such as the ETH Zurich Code of Conduct for Scientific Collaboration, ETH Zurich Code of Conduct for Handling Donations or the ETH Zurich Foundation Code of Conduct) ensure that it does so.

In the case of externally funded research projects, the general framework – that is, the strategy, quality, risks and indirect costs – must be closely examined. This includes any requirements on the part of foreign funding organisations, for example, and considering the additional costs ETH would incur for the project. Although an increasing number of funding organisations co-finance overhead costs, external funds are rarely enough to cover the costs in full. Infrastructure is often a tight resource.

A clearly defined and transparent funding diversification strategy is crucial to keeping ETH Zurich on a sustainable track. It is also essential that the Federal Government's global budget remains on a stable footing going forward.

ETH Zurich third-party funding (Ø 2013–2017)



Financial accounting and reporting in full compliance with IPSASs

Since 1 January 2017, ETH Zurich's annual consolidated financial statements have been prepared in full compliance with International Public Sector Accounting Standards (IPSASs). Following the expiry of the transitional provisions that applied over the last two years, all applicable IPSASs have been fully implemented as of financial year 2017. From a transparency perspective, therefore, ETH Zurich is one of the few universities worldwide to undergo a full IPSAS audit.

As of this financial year, ETH Zurich's annual consolidated financial statements also include financial data on entities which ETH Zurich controls or over which it has significant influence.

As far as amounts are concerned, the controlled entities (IPSAS 34–38) have a minor effect on total net assets and no effect on the reserves. The first-time inclusion of the associated entities (IPSAS 36) increases total net assets by around 100 million Swiss francs. This is reflected in the reserves from associated entities. From a legal, or property-law, perspective, the entities remain independent and autonomous (see the section entitled "Consolidation methods" on page 90 for the definition of controlled and associated entities).

ETH Singapore SEC Ltd. and the Rübel Geobotanical Research Institute Foundation are now consolidated in the annual financial statements. The ETH Zurich Foundation and several other foundations are accounted for using the equity method.

The Singapore–ETH Centre, ETH Zurich's only research centre outside Switzerland, develops sustainable solutions to global challenges in Switzerland, Singapore and nearby regions. The Centre also serves as an offshore partner to ETH Zurich and an intellectual hub for academic training and entrepreneurship. For more information, visit www.sec.ethz.ch.

The Rübel Geobotanical Research Institute Foundation (www.geobot.ethz.ch) supports the professorship for plant ecology and the professorship for plant ecological genetics, which are part of the Institute of Integrative Biology at ETH Zurich's Department of Environmental Systems Science.

The ETH Zurich Foundation is an independent, non-profit organisation under private law that aims to promote teaching and research at ETH Zurich. Through its activities, it helps to maintain and extend ETH Zurich's leading position among international universities by judiciously supplementing federal contributions with private funding. It awards grants to selected projects within the strategic initiatives set by the ETH Zurich Executive Board. In this way, funds are pooled and invested efficiently. For more information, visit www.ethz-foundation.ch/en/.

Annual consolidated financial statements in brief

The implementation of IPSASs has a significant impact on the annual financial statements. For example, revenue and expenses are recognised in the accounting period in which resources are generated or consumed. Furthermore, consolidated financial statements have been prepared in accordance with IPSAS for the first time for financial year 2017. This means that financial data on entities which ETH Zurich controls or over which it has significant influence are also included. The definition of these entities is based on accounting aspects and is intended to reflect the economic position. It differs from the legal position of these legally autonomous entities.

A consolidated surplus of 137 million Swiss francs was reported for 2017 (an increase of 6 million Swiss francs or 4 percent compared with the previous year).

The consolidated operating revenue generated in 2017 amounted to 1,850 million Swiss francs (up by 82 million Swiss francs or 5 percent compared with the previous year). The federal contribution, which under IPSAS is made up of the federal financial contribution (in the narrower sense) and the contribution to accommodation, climbed to 1,367 million Swiss francs (a rise of 78 million Swiss francs or 6 percent). Within revenue from third-party funding, both revenue from donations and bequests (83 million Swiss francs) and revenue from research contributions (326 million Swiss francs) were roughly on a par with the previous year.

Consolidated operating expenses increased to 1,748 million Swiss francs in 2017 (up by 106 million Swiss francs or 6 percent compared with the previous year). This increase was driven primarily by higher personnel expenses: salaries and wages rose by 22 million Swiss francs or 3 percent, mostly because of the rise in average full-time equivalents by 238 FTEs (3 percent) to 9,281 FTEs. Net pension costs increased primarily as a result of the switch from IPSAS 25 to IPSAS 39. Depreciation charges were up (by 9 million Swiss francs or 10 percent) due to larger investments in 2016.

Total consolidated net assets rose by 312 million Swiss francs (14 percent) to 2,569 million Swiss francs at the end of 2017. Debt was down by 288 million Swiss francs, mainly because of the decrease in net defined benefit liabilities. Equity, on the other hand, increased by 600 million Swiss francs to 759 million Swiss francs, mostly due to the positive trend in valuation reserves (cumulative actuarial gains on the defined benefit liability). Likewise, dedicated reserves (earmarked for donations and bequests as well as election commitments to newly appointed professors, for example) rose by 33 million Swiss francs and free reserves by 136 million Swiss francs. In addition, since financial year 2017, equity has also included reserves from investments in associated entities, which are equal to the carrying amount of the investment in those entities (104 million Swiss francs). Overall, this resulted in a substantial increase in the equity ratio to 30 percent at the end of 2017 (previous year: 7 percent).

Details on the annual consolidated financial statements can be found on page 82 onwards.

Consolidated financial statements

Rounding differences: The figures presented in this document may not add up precisely to the total amounts presented in the tables. Changes are calculated on unrounded amounts and may differ from a figure that is based on the rounded amounts presented in the tables.

Consolidated statement of financial performance

CHF million	Note	2017	2016
Federal financial contribution		1,201	1,128
Federal contribution to accommodation		166	161
Total federal contribution	1	1,367	1,289
Tuition fees and other utilisation fees	2	24	22
Swiss National Science Foundation (SNSF)		132	129
Commission for Technology and Innovation (CTI)		23	19
Special federal funding of applied research		23	40
EU Framework Programmes for Research and Innovation (FP)		64	57
Industry-oriented research (private sector)		49	49
Other project-oriented third-party funding (incl. cantons, municipalities, international organisations)		35	30
Research contributions, mandates and scientific services	3	326	324
Donations and bequests	4	83	84
Other revenue	5	51	48
Operating revenue		**1,850**	**1,768**
Personnel expenses	6	1,115	1,020
Other operating expenses	7	515	514
Depreciation	15, 17	98	89
Transfer expenses	8	21	20
Operating expenses		**1,748**	**1,642**
Operating result		**102**	**126**
Net finance income/expense	9	**21**	**6**
Share of surplus/deficit of associated entities and joint ventures	14	**15**	**0**
Surplus (+) or deficit (–)		**137**	**131**

The prior period (2016) was not restated; the information was restated as of 1 January 2017.

Consolidated balance sheet

CHF million	Note	31.12.2017	31.12.2016
Assets			
Cash and cash equivalents	10	192	142
Current receivables from non-exchange transactions	11	243	9
Current receivables from exchange transactions	11	14	12
Current financial assets and loans	16	991	910
Inventories	12	6	7
Prepaid expenses and accrued income	13	24	22
Total current assets		**1,470**	**1,102**
Property, plant and equipment	15	447	440
Intangible assets	15	3	1
Non-current receivables from non-exchange transactions	11	492	658
Non-current receivables from exchange transactions	11	0	0
Investments in associated entities and joint ventures	14	104	0
Non-current financial assets and loans	16	3	3
Co-financing	17	50	52
Total non-current assets		**1,099**	**1,154**
Total assets		**2,569**	**2,257**
Liabilities and equity			
Current liabilities	18	81	79
Current financial liabilities	19	0	0
Accrued expenses and deferred income	20	76	73
Short-term provisions	21	44	39
Short-term liabilities		201	191
Dedicated third-party funds	23	663	638
Non-current financial liabilities	19	19	17
Net defined benefit liabilities	22	893	1,218
Long-term provisions	21	34	34
Long-term liabilities		1,609	1,907
Total liabilities		**1,810**	**2,098**
Valuation reserves		–527	–816
Dedicated reserves		623	590
Free reserves		540	404
Co-financing of state-owned real estate	17	50	52
Reserves from associated entities	14	104	0
Accumulated surplus (+)/deficit (–)		–31	–71
Total equity		**759**	**159**
Total liabilities and equity		**2,569**	**2,257**

The prior period (2016) was not restated; the information was restated as of 1 January 2017. As a result, the items reported in equity as of 31 December 2017 for the first time included reserves from associated entities. Together with the sharp change in the defined benefit liability (CHF +290 million) in the valuation reserves, this effect (CHF +104 million) was responsible for two-thirds of the rise in equity and the equity ratio (see the consolidated statement of changes in equity on page 86 and the section entitled "Restatement of the annual financial statements as of 1 January 2017" starting on page 88).

Consolidated statement of changes in equity

CHF million	Valuation reserves a	Dedicated donations and bequests	Teaching and research reserves b	Infrastructure and administration reserves c	Dedicated reserves	Free reserves d	Co-financing of state-owned real estate	Reserves from associated entities e	Accumulated surplus (+)/deficit (–) f	Total equity
2017										
As of 1.1.2017 (not restated)	**– 816**	**358**	**180**	**51**	**590**	**404**	**52**	**0**	**– 71**	**159**
Changes from restatement as of 1.1.2017								**90**	**84**	**174**
As of 1.1.2017	**– 816**	**358**	**180**	**51**	**590**	**404**	**52**	**90**	**13**	**333**
Surplus (+) or deficit (–)									**137**	**137**
Changes from defined benefit liability	290									**290**
Revaluation of financial assets	0									**0**
Hedging transactions	0									**0**
Total items directly recognised in equity	289									**289**
Reclassifications in equity	0	30	– 3	7	33	136	– 2	15	– 182	0
Total changes	**289**	**30**	**– 3**	**7**	**33**	**136**	**– 2**	**15**	**– 45**	**426**
As of 31.12.2017	**– 527**	**389**	**177**	**57**	**623**	**540**	**50**	**104**	**– 31**	**759**
2016										
As of 1.1.2016	**– 563**	**332**	**153**	**41**	**526**	**392**	**51**	**0**	**– 126**	**281**
Surplus (+) or deficit (–)									131	131
Changes from defined benefit liability	– 254									**– 254**
Revaluation of financial assets	0									**0**
Hedging transactions	0									**0**
Total items directly recognised in equity	– 253									**– 253**
Reclassifications in equity	0	26	28	10	64	12	1	0	– 76	0
Total changes	**– 253**	**26**	**28**	**10**	**64**	**12**	**1**	**0**	**55**	**– 122**
As of 31.12.2016	**– 816**	**358**	**180**	**51**	**590**	**404**	**52**	**0**	**– 71**	**159**

a The negative valuation reserves (CHF -527 million as of 31 December 2017) mainly comprise cumulative net actuarial and investment losses on the defined benefit liability (not recognised in surplus or deficit). The change (CHF +290 million) was responsible for 48 percent of the rise in equity and resulted from changes in actuarial assumptions and the switch from IPSAS 25 to IPSAS 39 (see the section entitled "Restatement of the annual financial statements as of 1 January 2017" starting on page 88).

b Dedicated teaching and research reserves of CHF 177 million included election commitments to newly appointed professors of CHF 97 million as of 31 December 2017 (previous year: CHF 109 million).

c Dedicated infrastructure and administration reserves increased as a result of reserves recognised for delayed construction projects. These were partly offset by a CHF 10 million reduction in risk capital.

d Free reserves reflect funds that mainly originate from self-generated revenues (including treasury) or completed research projects that show a surplus. Free reserves provide scope for strategic initiatives, contribute to more reliable planning and enable a flexible response to short-term declines in revenue or currency losses. The change in free reserves (CHF +136 million) was responsible for 23 percent of the rise in equity.

e Reserves from associated entities comprise ETH Zurich's share of the equity of those entities. The first-time inclusion of the associated entities was the reason for 17 percent of the rise in equity.

f The accumulated deficit is the residual of total equity less the reserve items presented separately. It shows the cumulative results at the reporting date and comprises the surplus/deficit carried forward, the surplus or deficit for the period and reclassifications in equity. Reclassifications in equity comprise the surplus or deficit realised in the reporting period and allocated to the reserves.

Consolidated cash flow statement

CHF million	Note	2017	2016
Cash flows from operating activities			
Surplus (+) or deficit (–)		**137**	**131**
Depreciation	14, 17	98	89
Share of surplus/deficit of associated entities and joint ventures		– 15	0
Net finance income/expense (non-cash)		– 16	– 4
Increase/decrease in net working capital		– 6	8
Increase/decrease in net defined benefit liabilities	22	45	– 22
Increase/decrease in provisions (short- and long-term)	21	6	2
Increase/decrease in non-current receivables	11	– 55	– 25
Increase/decrease in dedicated third-party funds	23	13	2
Reclassification and other (non-cash) income		– 1	0
Cash flows from operating activities		**205**	**181**
Cash flows from investing activities			
Investments			
Purchase of property, plant and equipment	15	– 100	– 119
Purchase of intangible assets	15	– 2	0
Increase in co-financing	17	0	– 2
Increase in loans	16	0	0
Increase in current and non-current financial assets	16	– 98	– 65
Total investments		**– 201**	**– 187**
Divestments			
Disposal of property, plant and equipment	15	1	0
Disposal of intangible assets	15	0	0
Decrease in co-financing	17	0	0
Decrease in loans	16	0	0
Decrease in current and non-current financial assets	16	35	16
Total divestments		**35**	**17**
Dividends received from associated entities and joint ventures	14	0	0
Cash flows from investing activities		**– 165**	**– 171**
Cash flows from financing activities			
Increase in short-term and long-term financial liabilities	19	0	0
Decrease in short-term and long-term financial liabilities	19	0	0
Cash flows from financing activities		**0**	**0**
Total cash flow		**40**	**10**
Changes from restatement as of 1.1.2017		9	
Cash and cash equivalents at the beginning of the period (1.1.)	10	**151**	**132**
Total cash flow		40	10
Cash and cash equivalents at the end of the period (31.12.)	10	**192**	**142**
Contained in the cash flows from operating activities are:			
Dividends received		2	1
Interest received		2	1
Interest paid		– 1	– 1

The prior period (2016) was not restated; the information was restated as of 1 January 2017.

Notes to the consolidated financial statements

General principles

Business activity

ETH Zurich is one of the leading international universities for technology and the natural sciences. It is well known for its excellent education, ground-breaking fundamental research and for implementing its results directly into practice.

Founded in 1855, ETH Zurich today has 20,600 students from 120 countries, including 4,100 doctoral students. It offers researchers an inspiring working environment and its students a comprehensive education. Twenty-one Nobel Laureates have studied, taught or conducted research at ETH Zurich, underlining the excellent reputation of the university.

Basis of accounting

These financial statements are consolidated financial statements covering the reporting period from 1 January 2017 to 31 December 2017. The reporting date is 31 December 2017.

Legal basis

The legal basis of ETH Zurich's accounting is formed of the version of the following (including directives and regulations) in effect in the reporting period:

- Federal Act on the Federal Institutes of Technology of 4 October 1991 (FIT Act; SR 414.110)
- Ordinance on the Domain of the Swiss Federal Institutes of Technology of 19 November 2003 (Ordinance on the ETH Domain; SR 414.110.3)
- Ordinance on the Finance and Accounting of the ETH Domain of 5 December 2014 (SR 414.123)
- Accounting Manual for the ETH Domain (Version 6.2)

Accounting standards

The annual consolidated financial statements of ETH Zurich have been prepared in accordance with the International Public Sector Accounting Standards (IPSASs). The underlying accounting provisions are set out in the Accounting Manual for the ETH Domain (Art. 34 Directives, Ordinance on the Finance and Accounting of the ETH Domain, SR 414.123).

IPSAS issued but not yet applied

The following IPSAS was issued before the reporting date. It only becomes effective later on and has not been early applied in these annual consolidated financial statements.

IPSAS 40	Public Sector Combinations

The above standard becomes effective on 1 January 2019. The effects on the annual consolidated financial statements are being systematically analysed.

Restatement of the annual financial statements as of 1 January 2017

In 2015, ETH Zurich switched to accounting under IPSASs with the exception of the following five items, which were applied as of 1 January 2017:

1. IPSAS 6–8, or 34–38 as is the case now (Consolidated and Separate Financial Statements, Investments in Associates, Interests in Joint Ventures), were not applied to investments held of 20 percent or above.

2. Receivables from non-exchange transactions (IPSAS 23) were not fully divided into a current and non-current portion based on the contractual provisions.

3. The provisions set out in the Accounting Manual for the ETH Domain governing provisions for holiday and overtime payments including long-service awards already earned were not fully implemented.

4. The provisions on financial instruments disclosures (IPSAS 30) were not fully implemented.

5. The provisions of IPSAS 23.76 ff. on transfers of services and goods in-kind were not applied.

IPSAS 39 Employee Benefits, which becomes effective on 1 January 2018, superseding IPSAS 25, was also early applied as of 1 January 2017.

The financial effects of implementing the five items above and applying IPSAS 39 are reflected in the restatement as of 1 January 2017. They are explained below:

CHF million	Balance sheet 31.12.2016 (before restatement)	Reclassifications: Distinction of current/ non-current receivables from non-exchange transactions	Revaluation: Expanded scope of consolidation	Revaluation: Net defined benefit liabilities (IPSAS 39)	Total changes	Opening balance sheet as of 1.1.2017
Total current assets	**1,102**	**224**	**14**		**238**	**1,340**
Total non-current assets	**1,154**	**– 224**	**94**		**– 130**	**1,024**
Total assets	**2,257**	**0**	**108**		**108**	**2,364**
Short-term liabilities	191					191
Long-term liabilities	1,907		15	– 81	– 66	1,840
Total liabilities	**2,098**		**15**	**– 81**	**– 66**	**2,031**
Valuation reserves	– 816					– 816
Dedicated reserves	590					590
Free reserves	404					404
Other equity	– 19		93	81	174	155
Total equity	**159**		**93**	**81**	**174**	**333**
Total liabilities and equity	**2,257**		**108**	**0**	**108**	**2,364**

- Receivables from non-exchange transactions were previously presented entirely as non-current. They were divided into a current and non-current portion for the first time on the basis of the contracts. CHF 224 million were identified as current and reclassified accordingly.

- The first-time application of IPSAS 34–38 (Consolidated and Separate Financial Statements, Investments in Associates, Interests in Joint Ventures) resulted in an increase in total assets of CHF 108 million as of 1 January 2017. This effect was due primarily to the recognition of associated entities (CHF +104 million) (for further details, see notes 14 and 29).

- The first-time application of IPSAS 39 Employee Benefits reduced net defined benefit liabilities by CHF 81 million. This is primarily attributable to employee contributions being included as a negative benefit. In addition, net interest was recognised and extended disclosures were provided (see note 22).

- The rule governing provisions for holiday and overtime payments including long-service awards already earned and the guidance in IPSAS 23.76 ff. on transfers of services and goods in-kind were fully implemented in the reporting period without restating information.

- Fully implementing the financial instruments disclosures had no effect on the financial statements, as the accounting policies for financial instruments have been applied since the 2015 reporting period (switch to IPSASs).

Accounting policies

The accounting policies are derived from the basis of accounting. The annual consolidated financial statements present a true and fair view of ETH Zurich's financial position, financial performance and cash flows, presenting revenue and expenses in the period in which they occur (accrual accounting).

The consolidated financial statements are based on historical cost. Exceptions to this rule are described in the following presentation of the accounting principles.

The annual consolidated financial statements of ETH Zurich are included in the consolidated financial statements of the ETH Domain.

Consolidation methods

The annual consolidated financial statements of ETH Zurich comprise ETH Zurich, all entities which ETH Zurich controls directly or indirectly and investments in associated entities.

Control means that ETH Zurich is exposed, or has rights, to variable benefits from its involvement with an entity and has the ability to affect those benefits through its power over the controlled entity. ETH Zurich has power if it has existing rights that give it the current ability to direct the relevant activities, i.e. activities which significantly affect the benefits from the controlled entity. This is normally the case if ETH Zurich directly or indirectly holds more than 50 percent of the voting rights or potential voting rights. These entities are consolidated.

All intra-economic entity receivables, liabilities, expenses and revenue from transactions within the economic entity as well as unrealised intra-economic entity surpluses are eliminated on consolidation.

Investments in associated entities with a 20 to 50 percent share of the voting rights and/or in entities where ETH Zurich has significant influence, but not control, are not consolidated, but are instead accounted for using the equity method and presented as investments in associated entities. Under the equity method, the value of the investment is calculated from cost, which is subsequently adjusted to reflect any changes in ETH Zurich's share of the associated entity's net assets. Significant balances and transactions with these entities are shown separately as items with associated entities.

Entities are consolidated on the basis of the single-entity financial statements of ETH Zurich and the controlled entities prepared in accordance with uniform policies and normally as at the same reporting date. Due to time constraints, there are cases where it is not possible to use the financial statements for the period ended 31 December 2017. Therefore, for financial statements which are immaterial in relation to the overall financial statements of ETH Zurich, prior-year financial statements were used and adjusted for significant transactions between the prior-year reporting date and 31 December 2017.

Investments newly acquired in the course of the reporting period are included in the annual consolidated financial statements if they meet the consolidation criteria and exceed the thresholds defined in the Ordinance on the Finance and Accounting of the ETH Domain two years in succession. Entities which are sold are included up until the date on which control is lost, which is usually the date of disposal. Gains on the disposal of controlled and associated entities are recognised in net finance income/expense.

Changes in ETH Zurich's ownership interests in controlled entities which do not lead to the loss of control of those entities are reported in the balance sheet as an equity transaction. The carrying amounts of the interests held by ETH Zurich and those of the non-controlling interests are adjusted to reflect the changes in the ownership interests in the controlled entities. Any difference between the amount by which the non-controlling interests are adjusted and the fair value of the consideration paid or received is recognised directly in equity and allocated to ETH Zurich.

If ETH Zurich loses control of a controlled entity, the deconsolidation gain or loss is recognised in the statement of financial performance. This gain or loss is determined from the difference between

- the total of the fair value of the consideration received and the fair value of the shares retained and
- the carrying amount of the assets (including goodwill) and liabilities of the controlled entity and of all non-controlling interests.

The table below shows the entities included in the annual consolidated financial statements of ETH Zurich.

Entity	Legal form	Currency	Domicile	Proportion of voting rights and participating share (in %)	
				31.12.2017	
ETH Zurich		CHF	Zurich		
Controlled entities					
ETH Singapore SEC Ltd.	Ltd.	SGD	Singapore	100	100
Rübel Geobotanical Research Institute Foundation	Foundation	CHF	Zurich	57	100
Associated entities					
ETH Zurich Foundation	Foundation	CHF	Zurich	15	100
Student Housing Foundation	Foundation	CHF	Zurich	22	50
Albert Lück Foundation	Foundation	CHF	Zurich	20	100
Archives of Contemporary History Foundation	Foundation	CHF	Zurich	25	100
Foundation for Contemporary Jewish History	Foundation	CHF	Zurich	20	100

A more detailed overview of the controlled and associated entities can be found in note 29.

Currency translation

The reporting is prepared in Swiss francs (CHF). All figures are shown in millions of Swiss francs (CHF million) unless indicated otherwise.

Foreign currency transactions are translated using the exchange rate at the transaction date, which is the date on which the transaction is initially recognised.

At each reporting date, monetary items in foreign currencies are translated using the closing rate. The resulting currency translation differences are recognised as finance income or finance expense. Non-monetary items are translated using the exchange rate at the transaction date.

Assets and liabilities of controlled entities with a different functional currency are translated using closing rates, and the statement of financial performance and cash flow statement using the average rate. Translation differences arising on the translation of net assets and statements of financial performance are recognised in equity.

The table below shows the principal currencies and their exchange rates.

	Closing rate as of		Average rate	
	31.12.2017	31.12.2016	2017	2016
Currency				
1 EUR	1.1701	1.0717	1.1116	–
1 USD	0.9743	1.0160	0.9846	–
1 SGD	0.7289	0.7040	0.7130	–

Revenue recognition

Each inflow of funds is assessed to determine whether it is an exchange transaction (IPSAS 9) or a non-exchange transaction (IPSAS 23).

In the case of an exchange transaction (IPSAS 9), the revenue is generally recognised when the goods are delivered or the services rendered. For project agreements, the service obligation not yet performed is allocated to liabilities. The revenue is billed and reported by reference to the stage of completion of the project, based on the costs incurred in the reporting period. In the case of a non-exchange transaction (IPSAS 23), a distinction is made between whether or not there is a performance or repayment obligation. If there is such an obligation, the corresponding amount is recognised as a liability at inception of the agreement and released to surplus or deficit according to the stage of completion. If there is neither an exchange nor a performance or repayment obligation in accordance with IPSAS 23, revenue is recognised in surplus or deficit in full in the reporting period and net assets/equity increased accordingly. This is usually the case with donations.

Revenue is structured as follows:

Total federal contribution
The contributions granted by the Federal Government to the ETH Domain are allocated to the two Federal Institutes of Technology and the four research institutions for the purpose of fulfilling the strategic objectives set by the ETH Board. The federal financial contribution granted to ETH Zurich (global budget) comprises the expenditure credit to cover basic teaching and research equipment (financial contribution in the narrower sense) and the investment credit covering its share of building investments for the Federal Government-owned property used by ETH Zurich. The investment credit is stated in the federal financial statements (Federal Office for Buildings and Logistics), while the total federal contribution in ETH Zurich's financial statements contains the federal financial contribution (in the narrower sense) and the federal contribution to accommodation. Both types of revenue are classified as non-exchange transactions (IPSAS 23). Federal contributions are recognised in the year in which they are paid.

The contribution to accommodation is equal to the accommodation expense, which is equal in amount to an imputed rent for the buildings owned by the Federal Government and used by ETH Zurich. Accommodation expense is reported within other operating expenses.

Tuition fees and other utilisation fees
Revenue from tuition fees and other utilisation fees is classified as an exchange transaction (IPSAS 9). As a rule, revenue is recognised when the goods are delivered or the services rendered. If services performed beyond the reporting date are material, they are accounted for on an accrual basis.

Research contributions, mandates and scientific services
Project-related contributions are given to ETH Zurich by various donors with the aim of promoting teaching and research. Project financing primarily relates to multi-year projects. Depending on the nature of the contributions, they are classified as either an exchange or a non-exchange transaction. How revenue is recognised depends on whether there is a performance or repayment obligation. Revenue from non-exchange transactions (IPSAS 23) is recognised when a receivable is legally binding, an inflow of resources is probable and there is no further performance obligation. Usually, a performance obligation exists and revenue is reported according to the stage of completion of the project in the accounting period based on the resources consumed.

Donations and bequests
Revenue from donations and bequests is classified as a non-exchange transaction (IPSAS 23). Grants where there is no conditional repayment risk are usually recognised as revenue in full when the agreement is signed.

Donations also include goods and services in-kind, which are distinguished as follows:

- Goods in-kind are recognised when the agreement is signed. Assets are posted in accordance with the applicable provisions (recognition as assets and depreciation).

- Donated rights to use assets in the sense of an operating lease are recognised as revenue and expense; those in the sense of a finance lease are measured at their fair value at inception of the agreement, if this is known, and depreciated over their useful life. If a performance obligation exists, a liability is stated and revenue recognised annually according to the services received. If there is no performance obligation, revenue is recognised upon recognition of the asset as a whole.

- Material services in-kind received are not recognised, but are instead disclosed and commented upon in the notes.

Other revenue
Among other items, other revenue includes other service revenue and real estate revenue. This revenue is classified as an exchange transaction (IPSAS 9). As a rule, revenue is recognised when the goods are delivered or the services rendered. If services are performed beyond the reporting date, they are accounted for on an accrual basis.

Cash and cash equivalents
Cash and cash equivalents comprise cash-in-hand, demand and term deposits with financial institutions and funds invested with the Federal Government with a term of up to 90 days. Cash and cash equivalents are measured at their nominal amount.

Receivables
Receivables from exchange (from goods and services) and non-exchange transactions are presented separately in the balance sheet.

In the case of receivables from non-exchange transactions (IPSAS 23), such as from SNSF and EU projects and from other donors, it is probable that there will be an inflow of funds in relation to the total contractual project volume. Therefore, the total amount of the project is usually recognised as a receivable at inception of the agreement if the fair value can be measured reliably. If the recognition criteria cannot be met, information is disclosed under contingent assets.

Non-current receivables of over CHF 10 million are stated at amortised cost using the effective interest method. Current receivables from exchange transactions are stated at cost when the revenue is realised.

Value adjustments are recognised on receivables on the basis of experience and a case-by-case assessment.

Inventories

Inventories are measured at the lower of cost and net realisable value. Cost is calculated using the weighted average cost method. Appropriate value adjustments are recognised for slow-moving inventories.

Property, plant and equipment

Items of property, plant and equipment are stated at cost less accumulated depreciation. They are depreciated over their estimated useful life using the straight-line method. The estimated useful lives are as follows:

Asset category	Useful life
Immovable assets	
Property	unrestricted
Leasehold improvements ≤ CHF 1 million	10 years
Leasehold improvements > CHF 1 million	according to components [1]
Buildings and structures	according to components [2]
Movable assets	
Machinery, equipment, tools, devices	5 years
Passenger vehicles, delivery vehicles, trucks, aircraft, ships, etc.	5 years
Furnishings	5 years
IT and communication	3 years

1. In the case of items of property, plant and equipment with a value of CHF 1 million or above, it is checked whether components (with a value that is significant in relation to the total value) need to be recognised and depreciated separately because they have a different useful life (components approach). 2. Useful life depends on the type of building, its purpose and the fabric of the building (20–100 years). Assets under construction are not yet depreciated.

Capitalised leasehold improvements and installations in leased premises are depreciated over the estimated useful life or over the term of the lease if shorter.

In the event of additions to property, plant and equipment, it is checked whether components with a value that is significant in relation to the total value need to be recognised and depreciated separately because they have a different useful life (components approach).

Investments which increase the economic benefits of an item of property, plant and equipment or extend its useful life are recognised in the carrying amount and depreciated over the estimated useful life. Pure repair and maintenance costs are recognised as an expense. Borrowing costs for assets under construction are capitalised.

The residual value of property, plant and equipment that is retired or sold is derecognised at the time of the asset's physical disposal. The gains or losses resulting from the derecognition of an item of property, plant and equipment are recognised as operating revenue or operating expenses.

Movable cultural items and works of art (e.g. teaching collections, art or historical collections, libraries) are not recognised as assets. An inventory of these items is kept.

Intangible assets

Intangible assets are recognised at cost. Standard software is amortised over three years using the straight-line method, with the amortisation charges recognised in surplus or deficit. Other intangible assets with an amortisation period required to be determined individually are amortised over their estimated useful life using the straight-line method.

Impairments (property, plant and equipment and intangible assets)

Property, plant and equipment and intangible assets are reviewed annually for indications of impairment. If specific indications are identified, an impairment test is performed. If the carrying amount permanently exceeds the value in use or net realisable value, an impairment is recognised in surplus or deficit in the amount of the difference.

Leases

Leases of property where ETH Zurich substantially assumes all the risks and rewards incidental to ownership are treated as finance leases. At inception of the lease, the assets and liabilities under a finance lease are recognised at the fair value of the leased property or, if lower, the present value of the minimum lease payments. Each lease payment is apportioned between the reduction of the outstanding liability and the finance charge. The reduction is deducted from the recognised lease liability.

Other leases where ETH Zurich is the lessee are recognised as operating leases. They are not carried in the balance sheet, but instead recognised as an expense in the statement of financial performance on an accrual basis.

Financial assets and loans

Financial assets are recognised at fair value if they are acquired with the intention of generating a profit from short-term fluctuations in price or if they are designated as financial assets at fair value (e.g. investments held without significant influence). Changes in value are recognised in surplus or deficit.

Other non-current financial assets that are held for an indefinite period and may be sold at any time for liquidity reasons or in response to changes in market conditions are classified as available for sale and stated at fair value or at cost if the fair value cannot be determined reliably. Unrealised gains and losses are recognised in equity and only transferred to surplus or deficit when the financial asset is sold or an impairment occurs. For instance, investments where there is neither control nor significant influence are recognised as available for sale.

Originated loans and fixed deposits are stated either at amortised cost (nominal value of less than CHF 10 million and current loans and fixed deposits of over CHF 10 million) or at amortised cost using the effective interest method (non-current loans and fixed deposits of over CHF 10 million). The effective interest method allocates the difference between the acquisition cost and the repayment amount (premium/discount) over the term of the asset using the net present value method. Impairment losses are recognised based on a case-by-case assessment.

Derivative financial instruments are used primarily for hedging or as a strategic position. Without exception, they are measured at fair value. Changes in value are usually recognised in surplus or deficit.

Investment property

Investment property is only reported separately if it is material. Otherwise, it is recognised in the balance sheet as property, plant and equipment and disclosed accordingly.

Co-financing of state-owned real estate

Co-financing is third-party funding acquired by ETH Zurich that is used for construction projects in property owned by the Federal Government. Co-financing is measured based on the measurement of the underlying property, which the Federal Government recognises at cost less accumulated depreciation. A property's ongoing depreciation therefore reduces the value of the co-financing to the same degree. Co-financing is reported at the same amounts on both the assets and the equity and liabilities side (equity) of the balance sheet.

Current liabilities

Current liabilities are usually recognised on receipt of the invoice. This item also includes current accounts with third parties (including social insurance institutions). Current liabilities are measured at their nominal amount.

Financial liabilities

Financial liabilities include monetary liabilities resulting from financing activities, as well as negative replacement values from derivative financial instruments. Monetary liabilities are usually interest-bearing. Liabilities that are due for repayment within twelve months of the reporting date are current. They are generally measured at amortised cost. Derivative financial instruments are measured at their fair value.

Provisions

Provisions are recognised when a past event gives rise to a present obligation, an outflow of resources is probable and the amount can be estimated reliably.

Net defined benefit liabilities

All ETH Zurich employees and pensioners are insured under the pension scheme the ETH Domain maintains at the collective institution "Swiss Federal Pension Fund PUBLICA" (PUBLICA). There are no other pension schemes at the controlled entities, which is why the further statements in the text refer to the pension scheme the ETH Domain maintains at PUBLICA. Net defined benefit liabilities correspond to the present value of the defined benefit obligations (DBO) calculated in accordance with the methods under IPSAS 39 less the fair value of the plan assets.

The defined benefit obligations are calculated annually by external actuarial experts using the projected unit credit (PUC) method. The calculation is made based on information about the beneficiaries (salary, vested benefits, etc.) and using actuarial assumptions, which include both demographic assumptions (retirement rates, disability rates, mortality rates, etc.) and financial assumptions (salary or pension trends, returns, etc.). The amounts calculated are discounted to the valuation date by applying a discount rate. Changes in estimates of economic conditions can significantly affect defined benefit obligations.

Under the PUC method, benefit entitlements are added evenly over the number of years of service to be rendered, rather than reflecting the actual distribution of retirement credits under the ETH Domain pension scheme, where they are graduated. The defined benefit obligations were measured based on the current membership base of the ETH Domain's pension scheme as of 31 October 2017, using actuarial assumptions as of 31 December 2017 (e.g. BVG 2015 actuarial tables) and the plan provisions of the ETH Domain pension scheme. The results were then adjusted using estimated pro rata cash flows as of 31 December 2017. The fair value of the plan assets is used, including estimated performance as of 31 December 2017.

Current service cost, past service cost resulting from plan amendments and curtailments, gains and losses on settlement, administrative costs and interest on the net defined benefit liabilities are presented in the statement of financial performance within personnel expenses.

Plan amendments and plan curtailments (past service cost) are recognised immediately in surplus or deficit in the period in which they occur provided they result in vested benefits. Actuarial and investment gains and losses on defined benefit plans are recognised directly in equity in the reporting period in which they occur.

Material other long-term employee benefits (e.g. future long-service awards) are also measured using the PUC method.

Dedicated third-party funds

Liabilities arising from dedicated projects where revenue is classified as a non-exchange transaction (IPSAS 23) are presented in the balance sheet as dedicated third-party funds within non-current liabilities; non-current because the projects usually last for several years and the current portion of the liability cannot be determined. They are measured based on the outstanding performance obligations at the reporting date, which are calculated from the total contractual project volume less services performed up to the reporting date.

Equity

Net assets/equity is the residual interest in the assets of an entity after deducting all its liabilities. Equity is structured as follows:

Valuation reserves

The following are recognised in the valuation reserves without affecting surplus or deficit:

- Revaluation reserves for available-for-sale financial assets recognised at fair value. Fair value changes are recognised in equity until the financial assets are sold.

- Valuation reserves from defined benefit obligations: Actuarial and investment gains and losses on defined benefit obligations or plan assets are recognised in equity.

- Valuation reserves from hedging transactions: If hedge accounting is used, positive and negative replacement values from hedging transactions are recognised in equity and released to surplus or deficit when the hedged transaction affects surplus or deficit.

Dedicated reserves

Dedicated reserves in equity include the following items:

- Donations and bequests: This item includes unused funds from donations and bequests that have certain conditions attached, but are not required to be classified as liabilities.

- Teaching and research reserves: This item indicates that various internal and external commitments exist and appropriate reserves have had to be recognised to cover them. These mostly comprise "election commitments", i.e. funds granted to newly elected professors under contractual arrangements to enable them to set up their professorship. These reserves are recognised when commitments have been made in writing and an employment contract is in place. These contributions to appointees are usually used over a period of three to five years.

- Infrastructure and administration reserves: These include reserves for fluctuations in the value of the securities portfolio (risk capital) and for delayed construction projects.

Dedicated reserves must (with the exception of election/appointment commitments) have been generated. They are recognised and released within equity.

Free reserves

Free reserves comprise:

- Free reserves of the Executive Board: There are no contractual conditions which would restrict the freedom to decide on their use.

- Free research reserves of the departments/professors: These primarily result from balances remaining on completed third-party funded projects. They are used for teaching and research and to cover losses (e.g. from foreign currency fluctuations). They are not restricted in terms of time or purpose, however.

Co-financing of state-owned real estate

Co-financing is third-party funding acquired by ETH Zurich that is used for construction projects in property owned by the Federal Government. These funds transferred to the Federal Government are presented as co-financing within non-current assets and the third-party funds recognised as revenue in surplus or deficit are presented as dedicated equity under the heading Co-financing.

Reserves from associated entities

This item comprises valuation reserves from the inclusion of the share of equity of investments in associated entities that are accounted for using the equity method.

Accumulated surplus/deficit
The accumulated surplus or deficit shows the cumulative results at the reporting date. It comprises the surplus/deficit carried forward, the surplus/deficit for the period and reclassifications in equity.

The surplus/deficit carried forward is accumulated annually as part of the appropriation of surplus/deficit. The surplus/deficit for the period includes the portion of the result not yet distributed. If currency translation differences arise on foreign consolidated entities on consolidation, they are recognised in equity, without affecting surplus or deficit.

Contingent liabilities and contingent assets
A contingent liability is either a possible obligation that arises from past events and whose existence will be confirmed only by the occurrence or non-occurrence of an uncertain future event not wholly within the control of the entity or a present obligation that arises from past events, but is not recognised because of its low probability of occurrence (less than 50 percent) or because the obligation cannot be measured reliably, as a result of which the criteria for recognising a provision are not met.

A contingent asset is defined as a possible asset that arises from past events and whose existence will be confirmed only by the occurrence or non-occurrence of an uncertain future event not wholly within the control of the entity. This only includes contingent assets receivable from third parties.

Financial commitments
Financial commitments are presented in the notes if they are based on events prior to the reporting date, they will definitely lead to obligations to third parties after the reporting date and their amount can be measured reliably.

Cash flow statement
The cash flow statement shows the cash flows from operating activities, investing activities and financing activities. It is presented using the indirect method, i.e. cash flows from operating activities are based on the surplus or deficit for the period, adjusted for the effects of transactions of a non-cash nature. "Total cash flow" represents the change in the balance sheet item "Cash and cash equivalents".

Estimation uncertainty and management judgements
Estimation uncertainty in the application of accounting policies
Preparation of the annual consolidated financial statements in accordance with generally accepted accounting principles requires the use of estimates and assumptions. Estimates and assumptions are based on past experience and other factors that are reasonable and justified, such as expectations regarding the occurrence of future events. Additionally, when applying the accounting policies, decisions have to be made that may have a significant effect on the amounts reported in the annual consolidated financial statements. Although these estimates are based on management's best knowledge, actual results may differ from those estimates. This applies to the following items in particular:

- Useful life and impairment of property, plant and equipment: The useful life of property, plant and equipment is defined and periodically reviewed bearing in mind the current technical environment and past experience. A change in the estimate may affect the future amount of the depreciation charges and the carrying amount. Estimates that could lead to a reduction in the carrying amount (impairment) are likewise made in the course of the regular impairment test.

- Provisions: These involve a higher degree of estimation than other balance sheet items and therefore may lead to a higher or lower cash outflow depending on the actual outcome of a past event.

- Net defined benefit liabilities: The net defined benefit liabilities are calculated based on long-term actuarial assumptions for the defined benefit obligations and for the expected returns on plan assets. The discount rate and future salary trends are key components in the actuarial valuation. These assumptions may differ from actual future developments.

- Recognition of donations: ETH Zurich regularly receives donations in the form of assets. Under IPSASs, donations must be recognised initially at fair value. The determination of that fair value requires management to make estimates.

- Discount rates: Uniform discount rates have been defined within the ETH Domain for use in discounting non-current receivables and liabilities as well as provisions. They are based on a risk-free rate and a premium for credit risk.

Management judgements in the application of accounting policies
The agreement with Immobilien ETHZF AG (a subsidiary of the associated entity the ETH Zurich Foundation) regarding the use of a building on the Hönggerberg campus was classified as a finance lease in financial year 2015, in particular as the agreement transfers substantially all the risks and rewards incidental to ownership to ETH Zurich and the term of the lease covers most of the useful life of the building.

Notes

1 Total federal contribution

The total federal contribution includes the expenditure credit or federal financial contribution (in the narrower sense), which is used to cover basic teaching and research equipment, but not the investment credit, which is stated in the federal financial statements (see Accounting policies, page 92). Instead of the investment credit, the total federal contribution includes the federal contribution to accommodation, which is used to cover rent charged by the Federal Government for the use of the buildings it owns. The related accommodation expense is a component of other operating expenses. Leasehold improvements and the buildings' operation and maintenance are not part of the contribution to accommodation; rather, they are financed out of the federal financial contribution (in the narrower sense).

In 2017, the financial contribution increased by CHF 73 million, or 6 percent, to CHF 1,201 million. The contribution to accommodation rose by CHF 4 million to CHF 166 million due primarily to the increase in the proportion of buildings used by ETH Zurich. The latter is offset to an equal degree by the accommodation expense for the use of property owned by the Federal Government (see note 7).

2 Tuition fees and other utilisation fees

This item of revenue primarily includes the tuition fees paid by students, various additional registration fees and fees for continuing education programmes.

Revenue from tuition fees and utilisation fees amounted to CHF 24 million compared with CHF 22 million in the previous year. Among other factors, the increase reflected the rise in the number of students and people attending continuing education courses.

3 Research contributions, mandates and scientific services

CHF million	2017	of which revenues (IPSAS 23)	of which revenues (IPSAS 9)	2016	Change absolute
Swiss National Science Foundation (SNSF)	132	132	0	129	2
Commission for Technology and Innovation (CTI)	23	23	0	19	4
Special federal funding of applied research	23	10	13	40	–17
EU Framework Programmes for Research and Innovation (FP)	64	64	0	57	7
Industry-oriented research (private sector)	49	18	31	49	0
Other project-oriented third-party funding (incl. cantons, municipalities, international organisations)	35	23	12	30	5
Total research contributions, mandates and scientific services	**326**	**269**	**56**	**324**	**1**

Revenue from research contributions, mandates and scientific services is mostly recognised according to the stage of completion of the project in the accounting period based on the resources consumed. Revenue is therefore impacted significantly by both the composition of the underlying project portfolio and the phase the projects are in. For projects in the initial phase, for example, which generate comparatively little expense, a small amount of revenue is usually recognised. Following this initial phase, the expenses usually increase, leading to the recognition of a correspondingly higher amount of revenue.

Federal research mandates showed a reduction in revenue (CHF –17 million). This was due in particular to the fact that this item was at an exceptionally high level in the previous year because of the financing for two new professorships.

EU Framework Programmes for Research and Innovation showed a rise in revenue (CHF +7 million), which was related to projects reaching a more advanced stage of completion. Of the EU research contributions reported in the amount of CHF 64 million, CHF 17 million comprised federal contributions granted directly from federal funds as part of the bridge financing (Horizon 2020) (previous year: CHF 11 million).

Revenue from other project-oriented third-party funding increased (CHF +5 million) A rise of CHF 12 million was attributable to the first-time inclusion of entities controlled by ETH Zurich in the annual consolidated financial statements (see the section entitled "Restatement of the annual financial statements as of 1 January 2017" starting on page 88). Conversely, ETH Zurich posted a CHF 7 million decline in revenue due to some exceptional contributions in the previous year.

Revenue from CTI projects was CHF 4 million higher year on year due to an increase in the volume of projects. SNSF revenue also rose as a result of higher project volumes.

Information on non-current receivables, changes in those receivables and dedicated third-party funds related to projects financed through the third-party funding category in question can be found in notes 11 and 23.

4 Donations and bequests

This item combines all types of grant (e.g. donations, bequests, bequeathments by will). These donations and bequests enable ETH Zurich to implement strategic projects faster and give new impetus to the focused development of research and teaching, including the necessary infrastructure.

Revenue from donations and bequests amounted to CHF 83 million. It resulted mostly from donation agreements signed in 2017 (CHF –2 million compared with the previous year). Such agreements are usually recognised in surplus or deficit in full in the year of signing.

5 Other revenue

CHF million	2017	2016	Change absolute
Licences and patents	2	2	0
Sales	7	7	– 1
Refunds	4	5	– 1
Other services	20	18	2
Real estate revenue	10	8	1
Profit from disposals (property, plant and equipment)	0	0	0
Other miscellaneous revenue	8	7	1
Total other revenue	**51**	**48**	**3**

6 Personnel expenses

CHF million	2017	2016	Change absolute
Professors	125	123	2
Scientific personnel	448	449	– 1
Technical and administrative personnel, apprentices, trainees	318	304	14
IC, Suva and other refunds	– 4	– 12	7
Total salaries and wages	**886**	**864**	**22**
Social insurances OASI/DI/IC/MB	56	55	2
Net pension costs	148	80	68
Accident and sickness insurance Suva (BU/NBU/KTG)	3	3	0
Employer's contribution to Family Compensation Fund (FAK/FamZG)	10	10	0
Total social insurance schemes and pension expenses	**218**	**147**	**70**
Other employer contributions	– 1	1	– 2
Temporary personnel	0	0	0
Change in provisions for untaken leave and overtime	5	0	5
Change in provisions for contributions to long-service awards	0	2	– 1
Other personnel expenses	6	5	1
Total personnel expenses	**1,115**	**1,020**	**95**

Salaries and wages increased by CHF 22 million, or 3 percent, year on year. This was related to the rise in average full-time equivalents by 238 FTEs to 9,281 FTEs (+3 percent). A rise of CHF 10 million, or 96 FTEs, was the result of the first-time inclusion of entities controlled by ETH Zurich in the annual consolidated financial statements (see the section entitled "Restatement of the annual financial statements as of 1 January 2017" starting on page 88). Details on the changes in personnel can be found in the Human resources and infrastructure section (starting on page 54).

The rise in net pension costs was due to the switch from IPSAS 25 to IPSAS 39 (see the sections "Restatement of the annual financial statements as of 1 January 2017" starting on page 88 and "Net defined benefit liabilities" starting on page 94). Net pension costs represent the net defined benefit liability accrued and allocated on a straight-line basis over the years of service, with the calculated return on plan assets reducing net pension costs. The net interest rate applicable under IPSAS 39 led to a sharp reduction in the interest rate used to calculate the return on plan assets, resulting in an increase in net pension costs (CHF +68 million).

The rise in the item Change in provisions for untaken leave and overtime (CHF +5 million) was due primarily to the adjustment to provisions for untaken leave and overtime recognised in full in 2017 (see note 21). Since the 2017 reporting period, it has been based on the actual hours on employees' working time accounts.

7 Other operating expenses

CHF million	2017	2016	Change absolute
Expenses for goods and materials	61	61	0
Premises costs	242	244	– 2
Other operating costs	212	209	3
Total other operating expenses	**515**	**514**	**1**

Premises costs declined year on year (CHF –2 million). The reduction was due to lower expenses for user-specific improvements and operating equipment. Conversely, higher accommodation expense for the use of property owned by the Federal Government represented the largest item within premises costs at CHF 166 million (CHF +4 million, see note 1).

Other operating costs rose (CHF +3 million), due mainly to higher IT and telecommunications expenses and higher fees for advisory services, while losses on receivables fell.

8 Transfer expenses

CHF million	2017	2016	Change absolute
Scholarships and grants to students and doctoral students	14	13	1
Contributions to research projects	3	2	2
Other transfer expenses	4	5	– 1
Total transfer expenses	**21**	**20**	**1**

9 Net finance income/expense

CHF million	2017	2016	Change absolute
Finance income			
Interest income	4	3	1
Income from investments	3	1	2
Changes in fair value of financial assets	17	6	11
Foreign currency gains	3	1	2
Other finance income	0	1	– 1
Total finance income	**27**	**13**	**15**
Finance expense			
Interest expense	1	1	0
Other financing costs for provision of capital	0	0	0
Changes in fair value of financial assets	2	4	– 2
Foreign currency losses	3	1	2
Impairment of loans and fixed deposits	0	0	0
Other finance expense	1	1	0
Total finance expense	**7**	**7**	**0**
Total net finance income/expense	**21**	**6**	**15**

Finance income increased year on year, due especially to the positive performance of the asset management mandates (see also note 16). Interest income consisted mostly of interest from unwinding of the discount on receivables (CHF 2.4 million).

Finance expense remained unchanged year on year. Interest expense contains the interest on the finance lease. Further information on the finance lease can be found in note 19.

10 Cash and cash equivalents

CHF million	31.12.2017	31.12.2016	Change absolute
Cash	1	1	0
Swiss Post	55	57	– 2
Bank	21	9	11
Short-term deposits (<90 days)	115	75	40
Total cash and cash equivalents	**192**	**142**	**49**

The change in cash and cash equivalents is closely related to ETH Zurich's investing and financing activities (see the consolidated cash flow statement on page 87). A significant portion of the cash and cash equivalents comprises deposits with the Federal Government (short-term deposits with a term of up to 90 days). These are funds collected from third parties that will not be used immediately and are placed with the Federal Government in accordance with the investment guidelines stipulated by the ETH Board.

Of the rise in bank deposits (CHF +11 million), CHF 6 million was attributable to the first-time inclusion of entities controlled by ETH Zurich in the annual consolidated financial statements (see the section entitled "Restatement of the annual financial statements as of 1 January 2017" starting on page 88).

There are no restrictions on the use of cash and cash equivalents.

11 Receivables

CHF million	31.12.2017	31.12.2016	Change absolute
Receivables from project contracts and donations	734	666	68
Other receivables	1	2	– 1
Value adjustments	0	0	0
Total receivables from non-exchange transactions	**734**	**667**	**67**
of which current	243	9	233
of which non-current	492	658	– 166
Trade accounts receivable	15	12	3
Other receivables	0	0	0
Value adjustments	– 1	0	– 1
Total receivables from exchange transactions	**14**	**12**	**2**
of which current	14	12	2
of which non-current	0	0	0

Receivables from non-exchange transactions reflect the total amount of contractual payments for mainly project-oriented research contributions which have not yet been transferred to ETH Zurich. Grants that have been promised but not yet transferred under donation agreements are also recognised as receivables from non-exchange transactions.

These receivables rose in the case of SNSF, CTI, EU and applied research projects. Receivables from donations were also higher.

The sharp change in the maturity of receivables from non-exchange transactions is attributable to the fact that the receivables have been divided into a current and non-current portion since the 2017 reporting period (see the section entitled "Restatement of the annual financial statements as of 1 January 2017" starting on page 88).

Due dates of receivables

CHF million	Total receivables	Not past due	Past due up to 90 days	Past due 91 to 180 days	Past due more than 180 days
31.12.2017					
Gross amount	**749**	**742**	**6**	**1**	**1**
Receivables from non-exchange transactions	734	732	2	1	0
Receivables from exchange transactions	15	10	4	0	1
Value adjustments	**– 1**	**0**	**0**	**0**	**– 1**
of which individually impaired	0	0	0	0	0

Value adjustments on receivables

Value adjustments arising on receivables were small in amount (CHF –1 million) and related to receivables from exchange transactions.

12 Inventories

Inventories comprise purchased inventories (there are no self-produced inventories). Among other items, they include recurring inventories such as chemicals, laboratory materials and materials used for experiments in teaching and research.

Inventories stood at CHF 6 million (previous year: CHF 7 million).

13 Prepaid expenses and accrued income

CHF million	31.12.2017	31.12.2016	Change absolute
Interest	0	0	0
Prepaid expenses	23	0	23
Other prepaid expenses and accrued income	1	21	–20
Total prepaid expenses and accrued income	**24**	**22**	**3**

Prepaid expenses have been presented separately for the first time in the reporting period (CHF 23 million). In the previous year, they were a component of other prepaid expenses and accrued income (CHF 19 million).

The largest items here are the library's media purchases, advance rental payments and advance payments for hardware and software maintenance agreements.

14 Investments in associated entities and joint ventures

Associated entities are entities over which ETH Zurich is able to exercise significant influence (see the section entitled "Consolidation methods" on page 90). Details on material associated entities can be found in the section below. Further information on all associated entities is provided in note 29.

ETH Zurich did not have any joint ventures in the reporting period.

Material associated entities and individually immaterial associated entities

The summarised financial information for each material associated entity and for the individually immaterial entities in aggregate is set out below. For the purposes of equity method accounting, the financial statements and the amounts reported there were adjusted, with some simplifications, to conform to the accounting of ETH Zurich.

CHF million	ETH Zurich Foundation [1]	Student Housing Foundation [1]	Albert Lück Foundation [1]	Individually immaterial associated entities [2]
31.12.2017				
Reporting date used	**31.12.2017**	**31.12.2016**	**31.12.2016**	**31.12.2016**
Current assets	254	2	2	5
Non-current assets	171	108	55	5
Short-term liabilities	1	0	8	0
Long-term liabilities	349	37	33	3
Revenue	56	11	6	0
Tax expense	0	0	0	0
Pre-tax gain or loss attributable to discontinued operations	0	0	0	0
Surplus (+) or deficit (–)	13	2	1	0
Dividends received from the associated entity	0	0	0	0

1. Material associated entity. 2. Individually immaterial associated entities include: Archives of Contemporary History Foundation and Foundation for Contemporary Jewish History.

Unrecognised share of losses of associated entities

There was no unrecognised share of losses of associated entities, either for the reporting period or cumulatively.

15 Property, plant and equipment and intangible assets

CHF million	Machinery, equipment, furnishings, vehicles	IT hardware	Other movable assets [1]	**Total movable assets**	Property, buildings [2]	Assets under construction	**Total immovable assets**	**Total property, plant and equipment**	**Total intangible assets [3]**
2017									
Purchase value									
Changes from restatement as of 1.1.2017	2	0	0	2	3	0	3	**6**	**0**
As of 1.1.2017	**804**	**220**	**12**	**1,036**	**200**	**103**	**303**	**1,339**	**7**
Additions	48	21	7	77	2	21	23	**100**	**2**
Reclassifications	4	0	– 3	0	80	– 80	0	**0**	**0**
Disposals	– 15	– 10	0	– 25	0	0	0	**– 25**	**0**
As of 31.12.2017	**841**	**231**	**16**	**1,088**	**281**	**44**	**326**	**1,414**	**9**
Accumulated depreciation									
Changes from restatement as of 1.1.2017	1	0	0	1	1	0	1	**2**	**0**
As of 1.1.2017	**678**	**153**	**0**	**831**	**64**	**0**	**64**	**895**	**6**
Depreciation	49	29	0	78	18	0	18	**96**	**1**
Impairments	0	0	0	0	0	0	0	**0**	**0**
Reversed impairments	0	0	0	0	0	0	0	**0**	**0**
Reclassifications	0	0	0	0	0	0	0	**0**	**0**
Disposals value adjustments	– 14	– 10	0	– 24	0	0	0	**– 24**	**0**
As of 31.12.2017	**713**	**172**	**0**	**885**	**82**	**0**	**82**	**968**	**6**
Balance sheet value as of 31.12.2017	**127**	**60**	**16**	**203**	**199**	**44**	**244**	**447**	**3**
thereof leased assets					16		16	16	
2016									
Purchase value									
As of 1.1.2016	**765**	**172**	**13**	**950**	**190**	**90**	**280**	**1,231**	**7**
Additions	41	56	4	101	2	17	19	**120**	**0**
Reclassifications	4	1	– 5	0	4	– 4	0	**0**	**0**
Disposals	– 9	– 8	0	– 17	0	0	0	**– 17**	**0**
As of 31.12.2016	**802**	**220**	**12**	**1,034**	**196**	**103**	**299**	**1,333**	**7**
Accumulated depreciation									
As of 1.1.2016	**634**	**141**	**0**	**775**	**49**	**0**	**49**	**823**	**5**
Depreciation	52	19	0	72	15	0	15	**87**	**1**
Impairments	0	0	0	0	0	0	0	**0**	**0**
Reversed impairments	0	0	0	0	0	0	0	**0**	**0**
Reclassifications	0	0	0	0	0	0	0	**0**	**0**
Disposals value adjustments	– 9	– 8	0	– 17	0	0	0	**– 17**	**0**
As of 31.12.2016	**677**	**153**	**0**	**830**	**64**	**0**	**64**	**893**	**6**
Balance sheet value as of 31.12.2016	**125**	**67**	**12**	**204**	**132**	**103**	**235**	**440**	**1**
thereof leased assets					16		16	16	

1. Other movable assets include advance payments and movable assets under construction. 2. The Rübel Geobotanical Research Institution Foundation, an entity controlled by ETH Zurich, holds an investment property. It is not disclosed separately on materiality grounds. 3 Intangible assets comprise software and intangible assets in the implementation phase.

Property, plant and equipment can generally be divided into movable and immovable assets. Movable items of property, plant and equipment consist largely of technical/scientific equipment as well as information and communications technology (ICT) equipment, furnishings and vehicles.

ETH Zurich's immovable property, plant and equipment consists of five properties (CHF 19 million), one property under a finance lease (CHF 16 million) and leasehold improvements (CHF 165 million excluding assets under construction). The latter are user-specific structural adjustments to buildings taken by ETH Zurich. The majority of the properties used by ETH Zurich are owned by the Federal Government and are reported in the balance sheet of the Federal Government rather than that of ETH Zurich.

16 Financial assets and loans

CHF million	31.12.2017	31.12.2016	Change absolute
Securities and fixed deposits	192	151	41
Positive replacement values	0	0	0
Other financial assets	799	759	40
Loans	0	0	0
Total current financial assets and loans	**991**	**910**	**81**
Securities and fixed deposits	0	0	0
Other financial assets	3	3	0
Loans	0	0	0
Total non-current financial assets and loans	**3**	**3**	**0**

Current financial assets are obtained in particular by investing funds collected from third parties that will not be used immediately. Based on the applicable treasury agreement and the investment guidelines stipulated by the ETH Board, these funds are placed in the market or with the Federal Government. The third-party funds placed in the market are managed by Swiss banks under asset management mandates.

Funds deposited with the Federal Government with a term of three to twelve months were increased to CHF 765 million in 2017 (previous year: CHF 732 million), leading to a rise in other current financial assets.

The asset management mandates were increased in volume in 2017. This and the positive performance of the asset management mandates were reflected in current securities, discounted papers and fixed deposits (CHF +41 million). Other current financial assets also rose.

Other non-current financial assets include investments held by ETH Zurich in spin-offs where it has an interest of less than 20 percent.

Loan funding granted to students and doctoral candidates on preferential terms amounted to CHF 0.5 million (of which CHF 0.3 million comprised current loans). Loans to students and doctoral candidates are repayable within twelve months (current) or in instalments over a period of six years from the individual completing their studies (non-current). There were no past due loans or impairment losses on loans as of 31 December 2017.

17 Co-financing

CHF million	2017	2016	Change absolute
Purchase value			
Changes from restatement as of 1.1.2017	0	0	0
As of 1.1.	**62**	**60**	**2**
Additions	0	2	–2
Disposals	0	0	0
As of 31.12.	**62**	**62**	**0**
Accumulated depreciation			
Changes from restatement as of 1.1.2017	0	0	0
As of 1.1.	**10**	**9**	**2**
Depreciation	2	2	0
Disposals	0	0	0
As of 31.12.	**12**	**10**	**2**
Balance sheet value as of 31.12.	**50**	**52**	**–2**

18 Current liabilities

CHF million	31.12.2017	31.12.2016	Change absolute
Trade payables	25	19	7
Liabilities to social insurance institutions	15	13	2
Other current liabilities	41	47	–6
Total current liabilities	**81**	**79**	**2**

The increase in trade payables was partly offset by changes in the balances on settlement accounts related to project collaborations within other current liabilities.

19 Financial liabilities

Current and non-current financial liabilities

Non-current financial liabilities of CHF 19 million (CHF +3 million) consisted primarily of liabilities under the finance lease (CHF 16 million). The rise of CHF 3 million was attributable to the first-time inclusion of entities controlled by ETH Zurich in the annual consolidated financial statements (see the section entitled "Restatement of the annual financial statements as of 1 January 2017" starting on page 88).

Current financial liabilities were small in amount and unchanged year on year at the end of 2017.

Finance lease disclosures

CHF million	Future minimum leasing payments 2017	Future financial expenses 2017	Present value of future minimum leasing payments 2017
Due dates			
Due within 1 year	1	1	0
Due within 1 to 5 years	6	4	1
Due after more than 5 years	30	14	15
Total as of 31.12.	**37**	**20**	**17**

	2017
Leasing expenses	
Lease payments expensed in period	0
Additional details	
Future revenue from sublease (from non-cancellable contracts)	0

The only finance lease is for a property on the Hönggerberg campus.

20 Accrued expenses and deferred income

CHF million	31.12.2017	31.12.2016	Change absolute
Interest	0	0	0
Deferred income	52	0	52
Other accrued expenses and deferred income	24	73	–49
Total accrued expenses and deferred income	**76**	**73**	**2**

Deferred income has been presented separately for the first time in the reporting period (CHF 52 million). In the previous year, it was a component of other accrued expenses and deferred income (CHF 49 million).

The largest items in the reporting period were deferred income from exchange transactions and accrued expenses for construction projects and operation.

21 Provisions

CHF million	Provisions for untaken leave and overtime	Other long-term employee benefits (IPSAS 39)	**Total provisions**
2017			
Changes from restatement as of 1.1.2017	0	0	**0**
As of 1.1.2017	39	34	72
Creation (incl. increase)	5	5	10
Reversal	0	0	0
Appropriation	0	– 5	– 5
Increase in present value	0	0	0
As of 31.12.2017	**44**	**34**	**78**
of which short-term	44		44
of which long-term		34	34
2016			
As of 1.1.2016	38	32	70
Creation (incl. increase)	0	2	2
Reversal	0	0	0
Appropriation	0	0	0
Increase in present value	0	0	0
As of 31.12.2016	**39**	**34**	**72**
of which short-term	39		39
of which long-term		34	34

Current provisions consist of provisions for untaken leave and overtime. Non-current provisions relate to future long-service awards.

Provisions for untaken leave and overtime (CHF 44 million) increased by CHF 5 million year on year, as a transitional provisional for the implementation of IPSASs was fully implemented as of 31 December 2017 (see also note 6). In doing so, a switch was made from an approximation to the leave and overtime credits actually recorded.

There were no provisions for dismantling, litigation, guarantees, warranties or other provisions in the reporting period or in the previous year.

22 Net defined benefit liabilities

All ETH Zurich employees and pensioners are insured under the pension scheme the ETH Domain maintains at the collective institution "Swiss Federal Pension Fund PUBLICA" (PUBLICA). There are no other pension schemes at the controlled entities, which is why the further statements in the text refer to the pension scheme the ETH Domain maintains at PUBLICA.

The standard IPSAS 39, Employee Benefits, was applied with effect from 1 January 2017. The effects are explained in the section entitled "Restatement of the annual financial statements as of 1 January 2017" (starting on page 88). The prior-year amounts are based on IPSAS 25 and have only been reclassified into the tables adjusted in line with IPSAS 39.

Legal framework and responsibilities

Legal requirements

Swiss pension plans must be run through a legally separate, trustee-administered pension institution. The law prescribes minimum benefits.

Organisation of the pension scheme

PUBLICA is an independent, state-run institution under public law.

The Board of Directors (Kassenkommission) is PUBLICA's most senior governing body. In addition to management, it is also responsible for the oversight and supervision of PUBLICA's Executive Board. The Board of Directors has 16 members, eight representing the insured members and eight representing the employers from among all the affiliated pension plans. This means that PUBLICA's most senior governing body is made up of an equal number of employer and employee representatives.

Each pension scheme has its own governing body made up of equal numbers of representatives. Among other things, it is involved in concluding the affiliation contract and decides on the appropriation of any surpluses. Each governing body is made up of nine employer representatives and nine employee representatives from the entities.

Insurance plan

In accordance with IPSAS 39, insurance plans are classified as defined benefit plans.

The pension plan is defined in the terms of the ETH Domain pension scheme applicable to employees and professors, which form part of the affiliation contract with PUBLICA. The pension plan provides benefits in excess of the minimum benefits required by law in the event of disability, death, old age and departure; i.e. it is what is known as an "enveloping" plan (obligatory and extraordinary benefits).

The employer and employee savings contributions are set as a percentage of the insured salary. A risk premium is charged for death and disability insurance. The administrative costs are paid by the employer.

The old-age pension is calculated from the credit balance in the retirement fund at the retirement date multiplied by the conversion rate specified in the terms. Employees have the option of drawing the retirement benefits as a lump sum. There are pension plans for different groups of insured persons. In addition, employees have the option of making additional savings contributions.

The risk benefits are determined depending on the projected savings capital, which attracts interest, and on the conversion rate.

Investment of assets

Investments are made by PUBLICA for all pension schemes (with the same investment profile) collectively.

As PUBLICA's most senior governing body, the Board of Directors bears overall responsibility for asset management. It is responsible for issuing and amending the investment policy and determines the investment strategy. The Investment Committee advises the Board of Directors on investment-related issues and oversees compliance with the investment policy and strategy.

Responsibility for implementing the investment strategy rests with PUBLICA's Asset Management. Asset Management also makes tactical decisions to deviate temporarily from the investment strategy weightings in order to generate added value compared to the existing strategy. Where individual asset classes are built up or reduced over a number of years, a pro rata strategy is calculated so as to enable transactions to be diversified over time.

Risks for the employer

The governing body of the ETH Domain's pension scheme made up of equal numbers of representatives can change the funding system (contributions and future benefits) at any time. The governing body may collect restructuring contributions from the employer while the scheme is underfunded within the meaning of pension law (Article 44 Occupational Pension Ordinance (BVV 2)) and if other measures are without success. If these are used to fund benefits in excess of the statutory minimum, the employer must indicate their agreement with this.

The definitive funding ratio in accordance with the Occupational Pensions Act (BVG) was not yet available at the time the annual consolidated financial statements were authorised for issue. The provisional regulatory funding ratio for the ETH Domain's pension scheme at PUBLICA, in accordance with the Occupational Pension Ordinance (BVV 2), was 108.0 percent at the end of the year (2016: 103.2 percent, definitive). The provisional economic funding ratio for the ETH Domain's pension scheme at PUBLICA was 89.5 percent at the end of the year (2016: 84.9 percent, definitive).

Special events

There were no plan amendments, plan curtailments or plan settlements required to be recognised in the current reporting period.

Net defined benefit liabilities

CHF million	31.12.2017	31.12.2016	Change absolute
Present value of defined benefit obligations	–4,265	–4,353	88
Fair value of plan assets	3,372	3,134	238
Recognised net defined benefit liabilities	**–893**	**–1,218**	**326**

The decline in net defined benefit liabilities was partly attributable to the switch to IPSAS 39 (CHF –81 million). Net defined benefit liabilities also fell because of changes in actuarial assumptions (in particular, the increase in the discount rate from 0.2 percent in the previous year to 0.3 percent as of 31 December 2017), the reduction in the rate of salary increase and the return on retirement savings.

Pension costs

CHF million	2017	2016	Change absolute
Current service cost (employer)	146	133	12
Past service cost	2	15	– 13
Gains (–)/losses (+) from plan settlements	0	0	0
Interest expense from defined benefit obligations	9	16	– 7
Interest income from plan assets	– 6	– 82	76
Administrative costs (excl. asset management costs)	2	0	2
Other	0	0	0
Total net pension costs incl. interest expense recognised in statement of financial performance	**152**	**82**	**71**

The increase in net pension costs was due in particular to the switch from IPSAS 25 to IPSAS 39. As IPSAS 39 introduces the recognition of net interest, the expected return on plan assets is now calculated using the discount rate. This resulted in lower interest income on plan assets in the statement of financial performance (CHF 6 million versus CHF 82 million in the previous year) and a correspondingly higher actuarial gain in equity (a gain of CHF 58 million versus a loss of CHF 314 million in the previous year). Interest expense from defined benefit obligations declined due to the lower discount rate of 0.2 percent as of 1 January 2017 (2016: 0.4 percent).

Current service cost (CHF 146 million) rose due to a slight increase in the membership base. Past service cost (CHF 2 million) fell as, in the previous year, the cumulative amount of contributions made to the pension fund for professors was recognised for the first time.

In the reporting period, the ETH Board made contributions of CHF 8.5 million to the ETH Domain's pension scheme. For ETH Zurich, this amount is reflected in the actuarial valuation as a pro rata employer contribution (CHF 4.1 million). The share of the contribution led to a difference compared with the net pension costs actually recognised (see note 6), as this contribution was not charged on to ETH Zurich.

Employer contributions of CHF 104.3 million and employee contributions of CHF 52.3 million are expected for the coming financial year.

Amounts directly recognised in equity

CHF million	31.12.2017	31.12.2016	Change absolute
Actuarial gains (–)/losses (+)	– 58	314	– 372
from change in financial assumptions	– 151	69	– 220
from change in demographic assumptions	0	180	– 180
from experience adjustments	93	65	28
Return on plan assets (excl. interest income)	– 232	– 61	– 171
Other	0	0	0
Amount recognised in equity	**– 290**	**254**	**– 543**
Cumulative amount of gains (–)/losses (+) recognised in equity	**529**	**818**	**– 290**

Actuarial gains recognised in equity amounted to CHF 58 million in 2017 (2016: loss of CHF 314 million). These and the return on plan assets resulted in a total cumulative loss of CHF 529 million as of 31 December 2017 (2016: CHF 818 million).

Change in the present value of defined benefit obligations

CHF million	2017	2016	Change absolute
Changes from restatement as of 1.1.2017	– 81	0	– 81
Present value of defined benefit obligations as of 1.1.	**4,272**	**3,984**	**288**
Current service cost (employer)	146	133	12
Interest expense from defined benefit obligations	9	16	– 7
Employee contributions	54	53	1
Benefits paid in (+) and paid out (–)	– 160	– 163	3
Past service cost	2	15	– 13
Gains (–)/losses (+) from plan settlements	0	0	0
Actuarial gains (–)/losses (+)	– 58	314	– 372
Other	0	0	0
Present value of defined benefit obligations as of 31.12.	**4,265**	**4,353**	**– 88**

The weighted average duration of the defined benefit obligations was 15.0 years as of 31 December 2017 (previous year: 15.6 years).

Change in the fair value of plan assets

CHF million	2017	2016	Change absolute
Changes from restatement as of 1.1.2017	0	0	0
Fair value of plan assets as of 1.1.	**3,134**	**2,997**	**137**
Interest income from plan assets	6	82	– 76
Employer contributions	108	104	4
Employee contributions	54	53	1
Benefits paid in (+) and paid out (–)	– 160	– 163	3
Gains (+)/losses (–) from plan settlements	0	0	0
Administrative costs (excl. asset management costs)	– 2	0	– 2
Return on plan assets (excl. interest income)	232	61	171
Other	0	0	0
Fair value of plan assets as of 31.12.	**3,372**	**3,134**	**238**

Reconciliation of net defined benefit liabilities

CHF million	2017	2016	Change absolute
Changes from restatement as of 1.1.2017	81	0	81
Net defined benefit liabilities as of 1.1.	**– 1,137**	**– 987**	**– 150**
Net pension costs incl. interest expense recognised in statement of financial performance	– 152	– 82	– 71
Amounts directly recognised in equity	290	– 254	543
Employer contributions	108	104	4
Obligations paid directly by the entity	0	0	0
Other	0	0	0
Net defined benefit liabilities as of 31.12.	**– 893**	**– 1,218**	**326**

Major categories of plan assets

		Listed	Not listed		Listed	Not listed
In %	**31.12.2017**			**31.12.2016**		
Liquidity	3	4	0	2	2	0
Bonds (in CHF) Confederation	6	6	0	6	6	0
Bonds (in CHF) excl. Confederation	11	12	0	11	12	0
Government bonds (in foreign currencies)	26	28	0	28	30	0
Corporate bonds (in foreign currencies)	14	15	0	15	16	0
Mortgages	0	0	0	0	0	0
Shares	31	33	0	30	32	0
Real estate	5	0	71	5	0	86
Commodities	2	2	0	2	2	0
Other	2	0	29	1	0	14
Total plan assets	**100**	**100**	**100**	**100**	**100**	**100**

PUBLICA bears the actuarial and investment risks itself. The investment strategy is defined in such a way that benefits under the policy can be provided at maturity.

There is no known pension plan property used by the employer.

Principal actuarial assumptions used as at the reporting date

In %	2017	2016	Change absolute
Discount rate as of 1.1.	0.20	0.40	– 0.20
Discount rate as of 31.12.	0.30	0.20	0.10
Expected salary development	0.50	0.90	– 0.40
Expected pension development	0.00	0.00	0.00
Interest on retirement savings	0.50	1.00	– 0.50
Life expectancy at age 65 – women (no. of years)	24.43	24.32	0.11
Life expectancy at age 65 – men (no. of years)	22.38	22.26	0.12

The discount rate is based on the spot interest rates for federal bonds published by the Swiss National Bank on a monthly basis and the expected cash flows of the ETH Domain's pension scheme at PUBLICA in accordance with existing prior-year data. The expected future rate of salary increase is based on reference economic variables. The rate of pension increase is the rate of pension increase expected for the average remaining term based on the financial position of the pension plan. The generation tables in BVG 2015 are applied for assumptions about life expectancy.

Sensitivity analysis (effect on present value of defined benefit obligations)

CHF million	Increase in assumption 2017	Decrease in assumption 2017	Increase in assumption 2016	Decrease in assumption 2016
Discount rate (change +/– 0.25%)	– 154	165	– 164	176
Expected salary development (change +/–0.25%)	17	– 17	25	– 24
Expected pension development (change +/–0.25%)	127	– 121	130	– 124
Interest on retirement savings (change +/–0.25%)	26	– 26	27	– 27
Life expectancy (change +/–1 year)	151	– 153	154	– 156

The sensitivity analysis determined the change in the defined benefit obligations in the event of a change in actuarial assumptions. In each case, only one of the assumptions was adjusted, while the other inputs remained unchanged. The discount rate, the projected rate of interest on retirement savings and the assumption about the rate of salary increase were increased or reduced by fixed percentage points. The sensitivity to mortality was calculated by reducing or increasing mortality by a flat rate, as a result of which the life expectancy of most age categories was increased or reduced by about one year.

23 Dedicated third-party funds

CHF million	31.12.2017	31.12.2016	Change absolute
Swiss National Science Foundation (SNSF)	249	229	20
Commission for Technology and Innovation (CTI)	48	32	16
EU Framework Programmes for Research and Innovation (FP)	167	169	– 2
Special federal funding of applied research	26	24	2
Industry-oriented research (private sector)	36	35	1
Other project-oriented third-party funding	31	21	10
Donations and bequests	105	127	– 22
Total dedicated third-party funds	**663**	**638**	**25**

Dedicated third-party funds reflect the outstanding performance obligations to donors at the reporting date. Their purpose is generally specified and the amount depends on the project volume and stage of completion.

SNSF and CTI projects showed the sharpest rise in dedicated third-party funds, partly as a result of the number of new projects for which financing had been provided, but which had used little of that financing to date because they are in the initial phase. Dedicated third-party funds classified as other project-oriented third-party funding increased by CHF 10 million. Of this, CHF 7 million was attributable to the first-time inclusion of entities controlled by ETH Zurich in the annual consolidated financial statements (see the section entitled "Restatement of the annual financial statements as of 1 January 2017" starting on page 88).

EU projects were on a downward trajectory. The reduction related to the more advanced stage of completion, but was weakened by currency effects.

24 Financial risk management and additional information about financial instruments

General

Financial risk management is embedded in ETH Zurich's general risk management, in respect of which annual reports are made to the ETH Board (see the Governance and sustainability section starting on page 66).

Financial risk management primarily addresses credit and default risk, liquidity risk and market risk (interest rate, foreign currency and other price risk).

The focus of risk management remains on credit risk. There are guidelines governing the investment of financial resources in order to reduce credit and market risk. The counterparties to a large proportion of the receivables and claims arising from financial assets are of high credit standing and solvency. Risk concentrations only exist in respect of those counterparties, which is why credit risk is regarded as low.

Furthermore, there are receivables and financial assets in foreign currencies which are hedged according to prevailing circumstances in order to minimise the risk.

Compliance with and the effectiveness of the guidelines are ensured by the internal control system (ICS) (see the Governance and sustainability section starting on page 66).

Credit and default risk

Maximum exposure to credit risk, breakdown by counterparty

CHF million	**Total**	Federal Government	European Commission FP [1]	SNSF, CTI, OASI social service, Suva	SNB and banks with government guarantee	Postfinance and other banks	Other counter-parties
31.12.2017							
Cash and cash equivalents	192	116	0	0	11	64	0
Receivables from non-exchange transactions	734	42	246	119	0	0	327
Receivables from exchange transactions	14	3	0	0	0	0	12
Financial assets and loans	994	765	0	0	0	9	220
Prepaid expenses and accrued income	1	0	0	0	0	0	1
Total	**1,936**	**926**	**246**	**119**	**11**	**73**	**560**

1. The remaining receivables due from the Federal Government (State Secretariat for Education, Research and Innovation [SERI]) under the Horizon 2020 bridge financing programme and the receivables from European universities arising from EU Framework Programmes for Research and Innovation are shown in the column headed European Commission.

The maximum exposure to credit risk corresponds to the carrying amounts in the balance sheet. The actual risk is low due to the fact that the counterparties to a large proportion of the financial assets are the Federal Government and other public-sector institutions.

Liquidity risk

ETH Zurich has processes and principles in place which guarantee that adequate liquidity is available to settle current and future obligations. This includes maintaining an adequate reserve of liquidity and tradable securities.

The following table shows the contractual maturities of the financial liabilities:

CHF million	**Total carrying amount**	**Total contract value**	Up to 1 year	1–5 years	More than 5 years
31.12.2017					
Non-derivative financial liabilities					
Current liabilities	81	81	81	0	0
Leasing liabilities	17	37	1	6	30
Financial liabilities	3	3	0	0	3
Accrued expenses and deferred income	24	24	24	0	0
Derivative financial liabilities	**0**	**0**	**0**	**0**	**0**
Total	**124**	**143**	**105**	**6**	**33**

Financial liabilities arise, most notably, from current operating liabilities. Under normal circumstances, expenses and investments are financed with self-generated funds. In some cases, investments are financed through lease agreements.

All financial liabilities are covered by liquidity and by short-term deposits with the Federal Government. There is no liquidity risk.

Market risk

Interest rate and price risk

Interest rate risk is not hedged. A one percentage point increase or decrease in the interest rate would increase or reduce surplus or deficit by around CHF 8 million.

The bonds under the asset management mandates are also taken into account in analysing interest rate risk. The other trading positions (excluding bonds) largely consist of equity funds holding both international and Swiss equities. A ten percent decrease in price would reduce surplus or deficit by CHF 14 million.

All trading positions exposed to price risk are held under asset management mandates with Swiss banks. There is a model in place for selecting the optimal portfolio for the investment strategy of the asset management mandate. This model is used to reconcile the risk associated with the assets and ETH Zurich's risk tolerance, and a reserve for fluctuations in value is recognised accordingly. It is ensured that expected minimum returns are achieved.

Foreign currency risk

Most foreign currency receivables are in euros and US dollars; they are hedged using derivative financial instruments according to prevailing circumstances. Most foreign currency risks in asset management mandates are hedged. Net of hedges, a fluctuation in the exchange rate of the currencies of +/–10 percent would impact on the statement of financial performance as follows:

CHF million	**Total**	CHF	EUR	USD	Other
31.12.2017					
Net currency balance	**1,660**	**1,641**	**3**	**1**	**15**
Sensitivity affecting financial performance +/–10%			0	0	2
Closing rate			1.1701	0.9743	

The net currency balance for other currencies came to CHF 15 million and was partly attributable (CHF 5 million) to the first-time inclusion of entities controlled by ETH Zurich in the annual consolidated financial statements (see the section entitled "Restatement of the annual financial statements as of 1 January 2017" starting on page 88). The remainder related primarily to asset management mandates.

Capital management

Managed capital is defined as equity excluding valuation reserves. ETH Zurich seeks to create a solid equity base. This base will enable the implementation of the performance mandate to be guaranteed. Legal regulations prohibit ETH Zurich from raising funds on the capital market.

The entities controlled by ETH Zurich may raise funds on the capital market.

Estimation of fair value

Because of their short-term maturity, the carrying amount of cash and cash equivalents and the carrying amounts of current loans, fixed deposits, receivables and current liabilities are a reasonable approximation of fair value.

The present value of future payments calculated using market interest rates is used as the fair value of non-current receivables from non-exchange transactions and of non-current loans.

The fair value of available-for-sale financial assets is based on actual values, provided they can be determined reliably, or reflects their cost.

The fair value of fixed-rate financial liabilities which are not traded publicly is estimated on the basis of payments falling due in the future, which are discounted using market interest rates.

The fair value of publicly traded fixed-rate financial assets and liabilities is based on quoted prices at the reporting date.

The fair value of finance lease liabilities is calculated on the basis of payments falling due in the future, which are discounted at market interest rates.

Classes and categories of financial instruments, by carrying amount and fair value

CHF million	**Total fair value**	**Total carrying amount**	Loans and receivables	At fair value through surplus or deficit	Available for sale	Financial liabilities measured at amortised cost
31.12.2017						
Cash and cash equivalents	192	192	192			
Receivables from non-exchange transactions	734	734	734			
Receivables from exchange transactions	14	14	14			
Financial assets and loans	994	994	765	226	3	
Prepaid expenses and accrued income	1	1	1			
Current liabilities	81	81				81
Finance lease liabilities	17	17				17
Other financial liabilities	3	3		0		3
Accrued expenses and deferred income	24	24				24

ETH Zurich does not hold any held-to-maturity financial assets.

Fair value hierarchy

Financial instruments measured at fair value are required to be disclosed within a three-level valuation hierarchy:

- Level 1: quoted prices in an active market for identical assets or liabilities;
- Level 2: valuation techniques where all significant inputs are based on observable market data;
- Level 3: valuation techniques where significant inputs are not based on observable market data.

CHF million	**Carrying amount / fair value**	Level 1	Level 2	Level 3
31.12.2017				
Financial assets	229	226	0	3
Financial liabilities	0	0	0	0

Net surplus or deficit by category

CHF million	Loans and receivables	At fair value through surplus or deficit	Available for sale	Financial liabilities
2017				
Interest income (+)/interest expense (–)	2	2		– 1
Income from investments		2	0	
Change of fair value		15		
Currency translation differences, net	1	0		0
Impairments	0		0	
Reversal of impairment	0			
Gains and losses reclassified from equity to the statement of financial performance			1	
Net surplus or deficit recorded in the statement of financial performance	**3**	**19**	**1**	**– 1**
Net surplus or deficit recognised in equity			**0**	
Total net surplus or deficit by category	**3**	**19**	**1**	**– 1**

Fair value changes (CHF 15 million) had the biggest impact on net surplus or deficit (see note 9).

25 Contingent liabilities and contingent assets

Contingent liabilities

Contingent liabilities amounted to a total of CHF 3 million at the end of 2017 (previous year: CHF 0.1 million). They related in part to project expenses that may or may not have to be reimbursed by the donor.

Contingent assets

Quantifiable contingent assets amounted to CHF 0.1 million at the end of 2017 (previous year: CHF 0 million).

In addition, ETH Zurich receives research funds and grants from third parties where, although they meet the significant characteristics of an asset, ETH Zurich's share of the future cash inflow cannot be quantified reliably. These comprise around 40 research agreements the Swiss National Science Foundation has with several contracting parties, the donation from Hansjörg Wyss for the Wyss Translational Center Zurich and the remaining inheritance from Dr Branco Weiss for the Society in Science programme (The Branco Weiss Fellowship) to support young researchers.

26 Financial commitments

CHF million	31.12.2017	31.12.2016	Change absolute
Financial commitments up to 1 year	7	8	– 1
Financial commitments from 1 to 5 years	0	0	0
Financial commitments > 5 years	0	0	0
Total financial commitments	**7**	**8**	**– 1**

At the end of 2017, there were financial commitments relating to the purchase of technical/scientific equipment.

27 Operating leases

CHF million	2017	2016	Change absolute
Due dates			
Due within 1 year	23	21	2
Due within 1 to 5 years	64	61	4
Due after more than 5 years	76	42	34
Future minimum payments for non-cancellable operating lease as of 31.12.	**164**	**124**	**40**
Leasing expenses			
Minimum lease payments	23	19	4
Conditional lease payments	0	0	0
Payments from subleasing	1	1	1
Leasing payments of current period	**24**	**20**	**4**
Additional details			
Future revenue from sublease (from non-cancellable contracts)	1	2	0

Operating leases relate mainly to rental agreements and to a lesser extent to IT licences.

28 Remuneration of key management personnel

The key management personnel of ETH Zurich are the five members of the Executive Board. The remuneration is disclosed in the section entitled Governance and sustainability (page 71).

29 Relationships with controlled and associated entities

At the controlled and associated entities listed below, ETH Zurich does not have any rights of access to the assets (for the definition of controlled and associated entities, see the section entitled "Consolidation methods" on page 90). Therefore, it cannot initiate a transfer of liquid funds or otherwise access the entities' funds.

Controlled entities

The entities listed below are consolidated.

	Legal form	Nature of collaboration/ business activity	Domicile	Currency	Jurisdiction	Proportion of voting rights and participating share (in %)		Reporting date used
						31.12.2017		
ETH Singapore SEC Ltd.	Ltd.	Strengthening the global position of Switzerland and Singapore in the field of environmental sustainability and engaging in appropriate research collaborations.	Singapore	SGD	Singapore	100	100	31.03.2017
Rübel Geobotanical Research Institute Foundation[1]	Foundation	Promoting geobotanical science (plant sociology, plant ecology, plant distribution, vegetation history).	Zurich	CHF	Switzerland	57	100	31.12.2016

1. The remaining 43 percent of the voting rights in the foundation are held by people determined by the founder. However, ETH Zurich has a 100 percent equity interest in the foundation.

Summarised financial information on the two controlled entities is set out in the table below:

CHF million	31.12.2017	of which ETH Singapore SEC Ltd.	of which Rübel Geobotanical Research Institute Foundation
Current assets	10	7	3
Non-current assets	4	1	3
Short-term liabilities	1	1	0
Long-term liabilities	10	7	3
Revenue	12	12	0
Surplus (+) or deficit (–)	0	0	0

Associated entities

All the associated entities listed are accounted for using the equity method.

	Legal form	Nature of collaboration/ business activity	Domicile	Currency	Jurisdiction	Proportion of voting rights and participating share (in %)	
Material associated entities						31.12.2017	
ETH Zurich Foundation[1]	Foundation	Promoting teaching and research at the Swiss Federal Institute of Technology Zurich.	Zurich	CHF	Switzerland	15	100
Student Housing Foundation	Foundation	Providing and operating low-cost housing for students in Zurich.	Zurich	CHF	Switzerland	22	50
Albert Lück Foundation	Foundation	Promoting teaching, research and study in the field of building and construction at ETH Zurich, initially in the current Department of Civil, Environmental and Geomatic Engineering and in its successor unit.	Zurich	CHF	Switzerland	20	100
Individually immaterial associated entities						31.12.2017	
Archives of Contemporary History Foundation	Foundation	Promoting, safeguarding the long-term existence of and extending ETH Zurich's Archives of Contemporary History as a documentation and research centre for general and Swiss contemporary history.	Zurich	CHF	Switzerland	25	100
Foundation for Contemporary Jewish History	Foundation	Setting up and promoting a documentation centre for contemporary Jewish history within ETH Zurich's Archives of Contemporary History.	Zurich	CHF	Switzerland	20	100

1. Even though ETH Zurich has less than 20 percent of the voting rights in the ETH Zurich Foundation, ETH Zurich can still exercise significant influence over the Foundation and is also the sole beneficiary. It is therefore classified as an associated entity.

Entities below the thresholds

The Ordinance on the Finance and Accounting of the ETH Domain contains more detailed guidance on consolidation. It also defines thresholds for inclusion in the annual consolidated financial statements. In accordance with Appendix 2 to this Ordinance, entities that meet the criteria for consolidation or equity method accounting, but fall below those thresholds must be disclosed as follows and are not included in the annual consolidated financial statements of ETH Zurich:

	31.12.2017
Controlled entities	
Quantity	4
Total assets (CHF million)	12
Associated entities	
Quantity	6
Total assets (CHF million)	14

30 Events after the reporting date

ETH Zurich's financial statements were authorised for issue by ETH Zurich's President and Vice President of Finance and Controlling on 26 February 2018. No significant events occurred prior to that date that would require disclosure in or an adjustment to ETH Zurich's financial statements for the period ended 31 December 2017.

EIDGENÖSSISCHE FINANZKONTROLLE
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SWISS FEDERAL AUDIT OFFICE

Reg. Nr. 1.18029.934.00120.002

Report of the statutory auditor

To the President of the Swiss Federal Institute of Technology, Zurich

Report on the audit of the consolidated financial statements

Opinion

We have audited the consolidated financial statements of the Swiss Federal Institute of Technology of Zurich (ETH Zurich), which comprise the consolidated statement of financial performance 2017, the consolidated balance sheet as of 31 December 2017, the consolidated statement of changes in equity and the consolidated cash flow statement for the year then ended, and notes to the consolidated financial statements, including a summary of significant accounting policies.

In our opinion the consolidated financial statements (pages 82 to 123) present fairly, in all material respects, the consolidated financial position of the ETH Zurich as of December 31, 2017, and its consolidated financial performance and its consolidated cash flows for the year then ended in accordance with the International Public Sector Accounting Standards (IPSAS) and legal requirements and the Accounting Manual for the ETH Domain.

Basis for Opinion

We conducted our audit in accordance with Swiss Law, International Standards on Auditing (ISAs), Swiss Auditing Standards and article 35ater of the Federal Act on the Federal Institutes of Technology (SR 414.110). Our responsibilities under those standards are further described in the Auditor's responsibilities for the audit of the consolidated financial statements section of our report. We are independent based on the Federal Auditing Act (SR 614.0), and we have fulfilled our other ethical responsibilities in accordance with these requirements.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

Other information in the Annual Report

The Executive Board of the ETH Zurich is responsible for the other information in the annual report. The other information comprises all information included in the annual report, but does not include the consolidated financial statements and our auditor's report thereon.

Our opinion on the consolidated financial statements does not cover the other information in the annual report and we do not express any form of assurance conclusion thereon.

In connection with our audit of the consolidated financial statements, our responsibility is to read the other information in the annual report and, in doing so, consider whether the other information is materially inconsistent with the consolidated financial statements or our knowledge obtained in the audit, or otherwise appears to be materially misstated. If, based on the work we have performed, we conclude that there is a material misstatement of this other information, we are required to report that fact. In this context, please refer to the section Report on other legal and regulatory requirements at the end of this report.

Responsibilities of the Executive Board of the ETH Zurich for the consolidated financial statements

The Executive Board of the ETH Zurich is responsible for the preparation and fair presentation of the consolidated financial statements in accordance with the International Public Sector Accounting Standards (IPSAS) and the legal requirements (Ordinance on the ETH Domain, SR 414.110.3; Ordinance on the Finance and Accounting of the ETH Domain, SR 414.123; Accounting Manual for the ETH Domain), and for such internal control as the Executive Board determines is necessary to enable the preparation of consolidated financial statements that are free from material misstatement, whether due to fraud or error.

In preparing the consolidated financial statements, the Executive Board of the ETH Zurich is responsible for assessing the ETH Zurich's ability to continue as a going concern, disclosing, as applicable, matters related to going concern.

Auditor's responsibilities for the audit of the consolidated financial statements

Our objectives are to obtain reasonable assurance about whether the consolidated financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance, but is not a guarantee that an audit conducted in accordance with Swiss law, ISAs and Swiss Auditing Standards will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these consolidated financial statements.

As part of an audit in accordance with Swiss law, ISA's and Swiss Auditing Standards, we exercise professional judgment and maintain professional scepticism throughout the audit. We also:

- Identify and assess the risks of material misstatement of the consolidated financial statements, whether due to fraud or error, design and perform audit procedures responsive to those risks, and obtain audit evidence that is sufficient and appropriate to provide a basis

for our opinion. The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the override of internal control.

- Obtain an understanding of internal control relevant to the audit in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the ETH Zurich's internal control.
- Evaluate the appropriateness of accounting policies used and the reasonableness of accounting estimates and related disclosures made.
- Conclude on the appropriateness of the Executive Board of the ETH Zurich's use of the going concern basis of accounting and, based on the audit evidence obtained, whether a material uncertainty exists related to events or conditions that may cast significant doubt on the ETH Zurich's ability to continue as a going concern. If we conclude that a material uncertainty exists, we are required to draw attention in our auditor's report to the related disclosures in the notes to the consolidated financial statements or, if such disclosures are inadequate, to modify our opinion. Our conclusions are based on the audit evidence obtained up to the date of our auditor's report. However, future events or conditions may cause the ETH Zurich to cease to continue as a going concern.
- Evaluate the overall presentation, structure and content of the consolidated financial statements, including the disclosures, and whether the consolidated financial statements represent the underlying transactions and events in a manner that achieves fair presentation.
- Obtain sufficient appropriate audit evidence regarding the financial information of the entities or business activities within the ETH Zurich to express an opinion on the consolidated financial statements. We are responsible for the direction, supervision and performance of the audit of the consolidated financial statements. We remain solely responsible for our audit opinion.

We communicate with the Executive Board of the ETH Zürich and the Audit Committee of the ETH Board regarding, among other matters, the planned scope and timing of the audit and significant audit findings, including any significant deficiencies in internal control that we identify during our audit.

Report on other legal and regulatory requirements

In accordance with the Federal Auditing Act and Swiss Auditing Standard 890, we confirm that an internal control system exists, which has been designed for the preparation of the consolidated financial statements according to the instructions of the ETH Board.

In accordance with Art. 21 par. 2 of the Ordinance on the Finance and Accounting of the ETH Domain, we confirm that no contradictions exist between the personnel reporting in the annual report (management report) and the consolidated financial statements. Likewise, we confirm that no contradictions exist between the financial figures in the annual report (management report) and the consolidated financial statements.

Furthermore, in accordance with Art. 21 par. 2 of the Ordinance on the Finance and Accounting of the ETH Domain, we confirm that risk management has been appropriately conducted according to the instructions of the ETH Board.

We recommend that the consolidated financial statements submitted to you be approved.

Berne, 26 February 2018 SWISS FEDERAL AUDIT OFFICE

Regula Durrer
Licensed audit expert

Dieter Lüthi
Licensed audit expert

Donations

Many companies, foundations, private individuals and alumni are keen to support education and research in partnership with ETH Zurich. In doing so, they make an important contribution to Switzerland as a business location and to its international competitiveness. On behalf of our researchers and students, ETH Zurich would like to thank all our donors and supporters for their generous contributions, and for the trust they place in us.

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We would also like to thank the many other donors who have provided vital support to ETH and who are not mentioned by name. Donors are listed pursuant to the ETH Zurich Code of Conduct for Handling Donations of 2 September 2014.

The ETH Zurich Foundation

The ETH Zurich Foundation is an independent, private and non-profit foundation whose mission is to promote teaching and research at ETH Zurich. Through its activities, the ETH Zurich Foundation supports ETH Zurich in maintaining and developing its leading position among the world's top universities. In this way, funding from the Swiss Federation is effectively supplemented by private financial contributions.

www.ethz-foundation.ch/en

LEGACIES AND BEQUESTS

Helping to shape the future

Philanthropic support for education and research is no longer a tradition limited to Anglo-Saxon cultures. Here in Switzerland, private individuals are also increasingly keen to promote scientific study – often beyond their own lifetime – by leaving part or all of their estate to the ETH Zurich Foundation.

There is a personal story behind every legacy and bequest made to the ETH Zurich Foundation. Many donors can already look back on a long and productive life, while others are in the middle of their career but have already decided to support ETH Zurich. This may be because they have studied, researched or taught here themselves, or would like to give something back to their alma mater. Or perhaps because they are eager to support science, and Switzerland as a centre of scientific excellence.

By making specific bequests, individuals can be sure that their legacy is used in exactly the way they want it to be. The ETH Zurich Foundation is exempt from tax, which means that the entire amount of the legacy or bequest goes towards the chosen cause or project.

www.ethz-foundation.ch/en/legacy

Dr Dorothée Wegmann, ETH alumna and long-serving staff member, supported ETH Zurich's Excellence Scholarship & Opportunity Programme during her lifetime. Later on, she also named the ETH Zurich Foundation as the sole heir in her will. On the ETH Zurich Foundation's website you can read more about the story of the chemist, who is fondly remembered by her former colleagues as an extremely meticulous proofreader of doctoral theses.

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