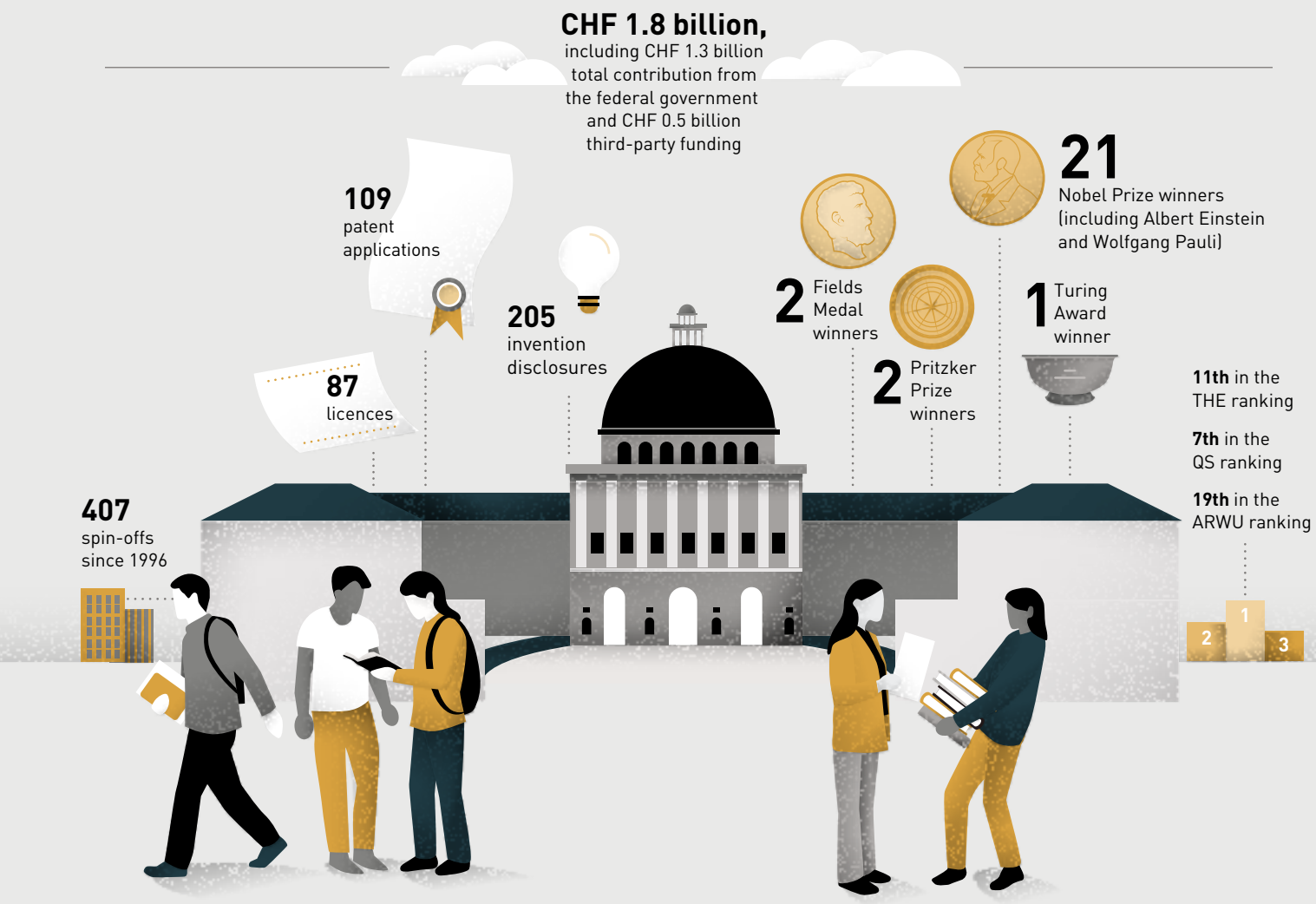
ETH zürich

Annual report
2018

ETH Zurich – Where the future begins

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 sophisticated solutions to the global challenges of today and tomorrow.



21,400
students, including

4,180
doctoral students, from

120
countries

530
professors

6,090
scientific staff *

2,770
technical and administrative staff *
and also

170
apprentices

* full-time equivalents (FTEs), annual average

Foreword from the President 3
Highlights 2018 4
Teaching 8
Research 18
Industry and society 28
Photo series: Thinking – and acting – creatively 38
Honours and awards 48
Human resources and infrastructure 54
Governance and sustainability 64
Finance 76

Consolidated financial statements 82
Report of the statutory auditor 122

Donations 126

Cover image: thinking – and acting – creatively
ETH Zurich provides a wide range of measures designed to encourage critical, independent thought and action. This year's annual report photo series features some prominent examples, including the Student Project House (SPH). At the SPH, the name says it all: here students find the space they need to work on their own projects. The Swiss academic aerospace initiative (ARIS) got its start here, for example. Today ARIS comprises an interdisciplinary team of around 50 students from ETH, the Lucerne University of Applied Sciences and Arts, and the Zurich University of Applied Sciences. Uniting research, education and industrial expertise in the field of aerospace technology, ARIS makes rockets that can hold their own at international competitions. The cover image shows ARIS President Oliver Kirchhoff (left) and team members Andrea Schorn and Aleksandar Totev, together with SPH staff member Bianca Curcio (right).

https://sph.ethz.ch/aris

“ETH needs to constantly reinvent itself.”

From its inception, ETH Zurich has stood out through its desire to explore undiscovered fields and pass on ground-breaking knowledge to the next generation of engineers and scientists. Behind the stories and numbers set out in this annual report are real people. They are what makes ETH so special: an institution renowned for the quality of its thinking, intellectual discourse and scientific discoveries.

Our university questions, challenges and comes up with answers. After all, one of our core tasks is to make knowledge available in ways that give Switzerland a competitive edge in a world increasingly dominated by digital technologies. By transferring knowledge and technology, we are deepening existing links with Swiss industry and building new partnerships. And our pipeline for new business ideas is fuller than ever, with 27 spin-offs founded in the past year alone.

ETH is on a good path. Over 21,000 young people now study with us. We have generated an impressive amount of highly promising research, and this is reflected in the prestigious awards that ETH members have won over the past year. From the Fields Medal to the European Inventor Award, from the Golden Lion award at the International Architecture Exhibition to the Marcel Benoist Swiss Science Prize: many ETH researchers have been honoured for their original thinking and scientific excellence. And yet the university cannot rest on its laurels, but needs to constantly reinvent itself. A prime example is the ETH+ initiative, set up to support ETH in exploring promising new areas of interdisciplinary research.

ETH provides not only an education, but an entire skill set. The type of qualifications that our graduates will need in 20 years’ time will in some cases be very different from today. This presents us with real challenges, not only in teaching, but also in recruiting new talent and leading large research teams. In all these areas, we have set the course for the future. And because lifelong learning is becoming increasingly important, we have unveiled a more systematic continuing education programme that we are continuously expanding.

I would like to thank every member of the ETH community, and especially my predecessor and the members of the Executive Board, for their hard work and dedication. Lastly, my thanks go to everyone who supports ETH – taxpayers and politicians, as well as decision-makers in industry and public office – for the trust they continue to place in our university.

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

Joël Mesot, President of ETH Zurich

Highlights 2018

1

1 Fields Medal

The International Mathematical Union (IMU) awarded the Fields Medal – the most prestigious award in the field of mathematics – to Alessio Figalli, Professor of Mathematics at ETH Zurich. Figalli received the award for his contributions to the theory of optimal transport and its applications in partial differential equations, metric geometry and probability.
→ page 50

2 Climate scenarios CH2018

Switzerland is becoming drier and hotter with less snow, and will struggle with heavier rainfall in the future – these are the conclusions that climate researchers from MeteoSwiss and ETH Zurich have reached. They form the basis for the Swiss government's climate change adaptation strategy. → page 35

2

3 Better job opportunities

Political scientists from ETH Zurich and the University of Stanford found that the chances of a refugee finding a job in Switzerland would improve if the cantonal allocation were better tailored towards the refugee's integration into the labour market. The scientists' approach is based on an algorithm that was developed using machine learning methods. → page 23

4 Construction in Basel

In September 2018, ETH Zurich laid the foundation stone for its new departmental building on the Schällemätteli campus in Basel. As of 2022, all research groups at the Department of Biosystems Science and Engineering will be united under one roof, close to important partners such as the University of Basel. → page 58

5 New antibiotics

The aim of a project funded by the Swiss National Science Foundation (SNSF) and ERC grants was to discover new antibiotics in previously unexplored habitats. While studying bacteria, ETH researchers identified new substances with antibiotic effects. A wide variety of microorganisms, such as bacteria and fungi, live on the leaves of plants. They develop substances with antibiotic properties which halt the growth and reproduction of other bacteria colonies on leaf surfaces. → page 25

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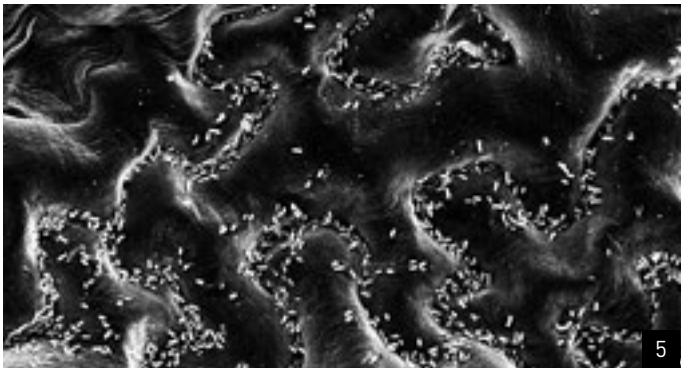


5

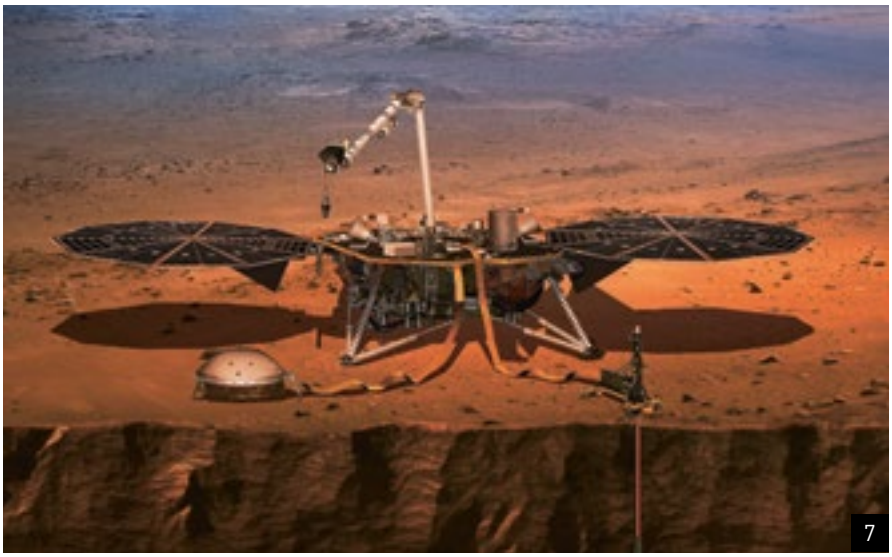
6 Golden Lion

In 2018 – for the first time ever – a Swiss pavilion won the Golden Lion at the International Architecture Biennale in Venice. The Best National Contribution recipient was the work of a team of four young ETH architects. Their idea was to heighten awareness of the architecture of one's own home by exaggerating internal features, such as an oversize kitchen or doors that are distorted. → page 31

7 ETH on Mars

In November 2018, NASA's InSight space probe landed on Mars. It carried a seismometer deploying sophisticated electronic instruments developed at ETH Zurich. The first test data are due to reach the Earth in early 2019, and ETH Zurich's Marsquake Service will be the first to interpret them. The researchers hope to gain new insights into the structure and composition of Mars, into comparable processes on Earth, and into the origins and development of the planets in our solar system. → page 21

6



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8 Quality plus

To maintain the university's pole position, ETH Zurich's Executive Board launched the ETH+ initiative at the end of 2017. Amongst other things, this involves creating professorships in promising areas of research. Based on the conviction that the ETH community itself best knows in which areas the greatest potential lies, the Executive Board launched an ETH-wide tender. In total, 68 idea sketches were submitted up to May 2018, nine of which have since been approved. → page 71

9 Driving in Duckietown

ETH researchers are experimenting with driverless vehicles using a fleet of small, self-driving taxis. In the Duckietown project, they work with colleagues from Montreal and Chicago on problems facing the developers of driverless vehicles worldwide. What looks like a kids' game is actually based on highly complex systems requiring seamless interaction between hardware components, sensors and motors. → page 17

9

10 Continuing education

Technological change is having a major impact on employment and demand for skills in industry and society. One of the effects of the rapid growth of information is hat continuing education becomes a lifelong task. This is the context in which ETH Zurich launched the School for Continuing Education in 2018, with new study courses offered in cybersecurity and data science, as well as customised continuing education programmes. → page 13

10

Fostering innovation in education

The Innovedum fund places 2 million Swiss francs annually at the disposal of the Rector to support initiatives that further develop education at ETH.

Number of Innovedum projects submitted and approved (2004–2018)

Teaching projects
Innovative projects that improve the quality of courses

Focal point projects
Projects to promote specific topics (e.g. interactive teaching); supported since 2010

Small projects
Projects with simple approval procedures and a budget of less than 30,000 Swiss francs; supported from 2007 to 2009

Degree programme initiatives
Initiatives to adapt the content of existing degree programmes or develop entirely new ones

Unsuccessful proposals
Projects not supported by the fund

Total proposals submitted **310**
Total projects approved **189**

Milestones in fostering innovation (selection)

2017 **Degree programme initiative**
The aim of this initiative is to incorporate cross-disciplinary skills (communication skills, critical thinking) into the curriculum of the Bachelor's programme in geospatial engineering, and to integrate them with existing core skills (modelling, programming).

2015 **Optimising courses in real time**
The online tool PELE – the personal electronic learning environment – gives lecturers the unprecedented ability to systematically optimise their courses in real time with the help of electronic data. Every week, the lecturer tracks how much time the students spend on tasks, noting where they progress quickly and where they have problems.

2012 **App for students**
An app for the teaching domain was funded and developed for the first time: EduApp helps ETH students in their everyday lives (study plans, maps, student workplaces) and also enables feedback in the classroom (clicker questions).

2007 **Electronic exams**
With the help of the Innovedum fund, a program was developed to help staff design exams flexibly, and give and grade them electronically. The project also contained a database of exam questions.

2002 **Flipped classroom**
The Filep fund, active until 2004, supported a flipped-classroom project on programming. As the name suggests, the traditional set-up is reversed: usually students learn in the lecture hall and do exercises at home. In a flipped classroom, they learn at home and come to the university to do the exercises.

Teaching

At ETH Zurich, knowledge transfer starts in schools. A range of teaching projects are used to familiarise pupils with the scientific approach to work and study. Above all, they should be motivated to develop their own creative ideas.

In the degree programmes, ETH Zurich continually adapts the learning environment to the current needs of students and lecturers, and to the future requirements of business and society. Teaching innovations are characterised by interaction, practical orientation and new technologies. ETH is creating more room for open and flexible learning spaces. These, along with aids such as online lesson evaluations or mixed reality techniques, are designed to help further improve teaching. ETH Zurich is also able to respond to the continuing strong growth in student numbers by holding e-tutorials and online exams. In 2018, more than 21,000 students enrolled across all study levels – an increase of almost 4 percent over the previous year.

ETH Zurich founded the School for Continuing Education to bring together its continuing education programmes and develop new courses. The university is also working with industry to develop customised continuing education programmes.

INNOVATION IN TEACHING

A more open curriculum

Teaching at ETH Zurich is becoming more project-based and interactive, preparing students for the professional demands of the future and their role in society.

Today's world is characterised by rapid information growth and technological change. "In our work of communicating knowledge, skills and values, it is increasingly a question of combining a solid education in science and technology with application-oriented and practical aspects – and placing it all in a broader context," says Andreas Vaterlaus, Vice-Rector for Curriculum Development and Professor for Physics and Education.

The trend towards project-based and applied teaching using interactive methods is also reflected in changes to ETH Zurich's buildings. Of course there are still auditoriums, especially for the big lectures at the beginning of a degree course, but there are also more and more open and flexible learning spaces: rooms with different zones, with places where people can meet and discuss, and quiet areas where students can concentrate and get on with their independent work.

> The aim is to combine a solid education in science and technology with application-oriented and practical aspects.

The point about these innovative teaching approaches is that, on the one hand, they employ new kinds of teaching aids, making the most of modern study methods, while on the other hand they improve communication between lecturers and students. For example, an online tool allows students to evaluate a lecture while it is still in progress, rather than at the end when it is too late for the students to benefit from the lecturer's changes.

The EduApp, one of the most successful projects from Innovedum (Innovedum projects are initiatives supported by the university aimed at further developing teaching at ETH), also enriches teaching by promoting interaction between lecturers and students. The EduApp contains a clicker function, for example. Lecturers can ask their audience questions during the lecture, like a quiz. In 2018, students on 216 different courses gave 274,693 answers to questions that not only made them think, but also helped to identify and clear up possible misunderstandings. The EduApp also offers a course forum for each lecture. It works like a group chat, where students can ask questions about the lecture and discuss them with the lecturers or their peers. In future, the application may even be able to coach students through the course or help them plan their studies.

Technological innovations aside, teaching is also constantly being rethought and redeveloped. Traditional lectures are increasingly giving way to other methods. In

In the flipped classroom, students discuss what they have learned at home.

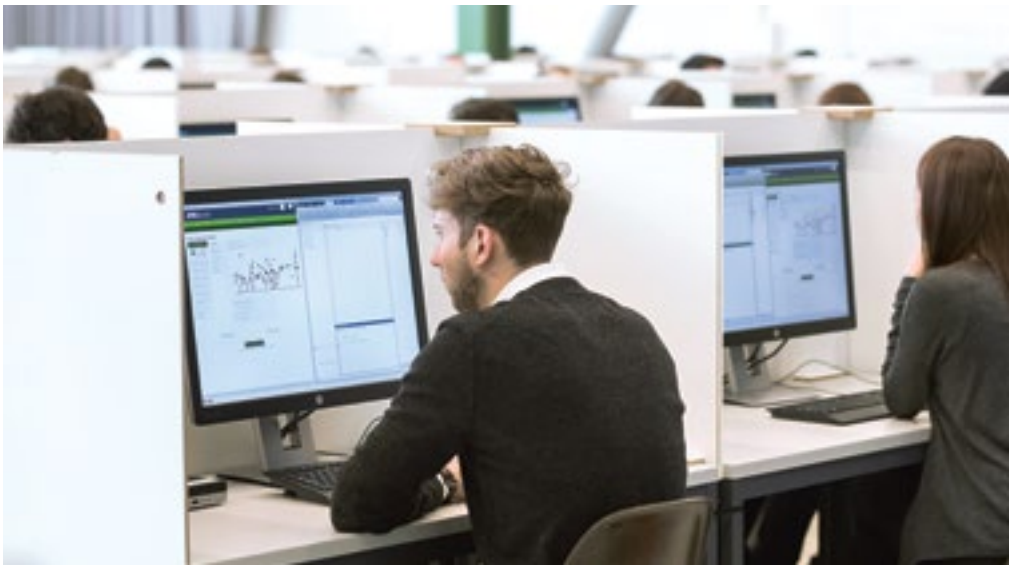
the flipped classroom, for example, students learn at home with self-study materials, then discuss what they have learned in class, for example by solving in-depth exercises in groups.

ETH studies today are less about acquiring encyclopaedic knowledge and more about having time to practise, to acquire knowledge for oneself and assess specific cases. Students should not only apply methods to complex problems and think critically about theories; they should also synthesise knowledge from different subjects and learn to work together across disciplines.

ETH Zurich continuously adapts the learning environment to the current needs of students and lecturers, in order to ensure that students receive a top-level education. With all the changes taking place, the only constant is the goal: to enable ETH graduates, as independent thinkers, to shape the future. ■

www.ethz.ch/innovative-teaching
www.ethz.ch/education

ETH Zurich increasingly uses self-study materials and in-depth exercises rather than traditional lectures.



The ONA building's multifunctional hall in Oerlikon during an online exam.

ONA E7 UP AND RUNNING

A new room for online exams

In Zurich-Oerlikon, a new room for online examinations has been in use since January 2018. It is the largest so far, with 240 seats. During the semester, the Department of Architecture uses this multifunctional hall for students' practical work. At the end of each semester, room ONA E7 is converted for the next exam session. The space can be partitioned into multiple sectors, which means that students from different courses can sit exams at the same time. Additional network cabling had to be installed and various hardware combinations intensively tested before the room could be used. Students acting as pilot users took part in ergonomic trials. Those working in room ONA E7 now have plenty of space for writing materials, exam aids – and of course snacks for calming the nerves. In view of the positive experience gained in ONA E7, the new hardware will soon replace that currently used in other exam rooms. ■

https://blogs.ethz.ch/id/2018/06/26/online-prufungen-an-der-eth-ona/
(available in German only)
www.ethz.ch/online-examinations

KITE AWARD

Honouring educators

For the second time, ETH Zurich's Lecturers' Conference presented the KITE Award, which recognises pioneering teaching concepts. Worth 10,000 Swiss francs, the prize went to Luke Fässler, Markus Dahinden and David Sichau in 2018. Their e-tutorials teach the basics of IT to more than 800 first-semester students from five departments.

Some 90 percent of prospective natural science students have little prior knowledge of this subject. Instead of making students cram the basics of IT through an introductory lecture, the three lecturers take a hands-on approach: students work in a practical setting or a virtual programming laboratory from day one, solving problems with real data from the subjects they are studying. For example, students have to contain an infectious disease or calculate an ocean current. The learning process is more fun that way, while simultaneously giving students serious grounding in IT. The e-tutorial, which is tailored to their knowledge, not only allows students to test their knowledge for themselves, it also helps them think independently and critically and work together efficiently in interdisciplinary teams. The personalised support system of the e-tutorials also allows one-to-one project presentations with a learning coach, individual feedback and mutual assessment, even with large courses. ■

www.ethz.ch/kite-award-en

GOLDEN OWL AWARDS

Awards for outstanding lecturers

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 receives this honour. The 2018 winners are:

- Professor Alexander Lehnerer (D-ARCH)
- Professor Walter Kaufmann (D-BAUG)
- Professor Markus Aebi (D-BIOL)
- Professor Randall Platt (D-BSSE)
- Dr Rolf Heusser (D-CHAB)
- Dr Marcel Frehner (D-ERDW)
- Paula de Avila Widauer (D-GESS)
- Professor Christopher Robert Pryce (D-HEST)
- Professor Juraj Hromkovic (D-INFK)
- Professor Christian Franck (D-ITET)
- Professor Volker Hoffmann (D-MTEC)
- Professor David J. Norris (D-MAVT)
- Professor Pietro Gambardella (D-MATL)
- Professor Manfred Einsiedler (D-MATH)
- Professor Jonathan Home (D-PHYS)
- Professor Kristopher McNeill (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 Markus Reiher from the Department of Chemistry and Applied Biosciences received the award in 2018. ■

www.ethz.ch/owl

Mixed reality brings new insights: technologies such as the HoloLens – used here in the field – have potential as training aids.

MIXED REALITY

Holograms in education

ETH uses the latest technologies in its teaching activities to enable students to see the surface of proteins, for example, or to access information about the diversity of lichens on trees.

Mixed reality is the name given to applications in which computer-generated images overlap with views of the real world. Placing virtual elements in a real environment often makes them easier to appreciate and understand. To explore the potential of this technology in a learning context, and thanks to a donation from ETH alumnus Adrian Weiss, the Educational Development and Technology administrative department (LET) purchased 12 HoloLens glasses and launched the Learning in Mixed Realities project in 2018.

LET invites lecturers to submit proposals for the use of these glasses in teaching. The first winning idea came from the Institute of Pharmaceutical Sciences. The glasses will be used in a two-week practical as part of the Computer-Assisted Drug Design course. Master's students can use the HoloLens to view three-dimensional images, or holograms, of pharmaceutically relevant protein structures. The camera built into the glasses allows students, with just a few manual steps, to "walk around" or dive into the structures. Students not only develop an accurate idea of the spatial distribution of a protein, they also learn how to select from a catalogue of millions of different molecules those that fit precisely into the indentations on the surface and can therefore be considered as potential new active substances.

Meanwhile, ETH lecturers have been carrying out other projects on the use of mixed reality in teaching. For example, environmental sciences students on a biodiversity field trip used a HoloLens app for the first time to map lichen colonies on tree bark. The app recognises trees by their bark texture and helps students by allowing them to tag colonies of the same species or retrieve detailed information about individual lichen varieties, such as sketches of typical patterns. ■

www.ethz.ch/hololens-news
www.ethz.ch/mixed-realities-learning

SCHOOL FOR CONTINUING EDUCATION

A new home for continuing education

Lifelong learning is becoming increasingly important. ETH Zurich is responding to this trend by founding a School for Continuing Education. It brings together various continuing education programmes and supports the development of new learning opportunities.

Continuing education is a key pillar of knowledge transfer at ETH Zurich.

One of the effects of the rapid growth of information is that continuing education becomes a lifelong task, with more and more working people moving flexibly back and forth between training and applying what they have learned. This is the context in which ETH Zurich launched the School for Continuing Education in 2018. Under the auspices of the new school, ETH's range of continuing education options – 17 MAS (Master of Advanced Studies), 8 DAS (Diploma of Advanced Studies) and 20 CAS (Certificate of Advanced Studies) courses, as well as further education courses and online programmes – are grouped into four categories: Environment, Infrastructure & Architecture; Technology, Management & Innovation; Public Policy & Governance; and Health, Life & Natural Science.

"By bringing courses together in this way we want to encourage dialogue between thematically related continuing education programmes," says Paolo Ermanni, Professor at the Institute of Design, Materials and Fabrication and, since 2015, Vice Rector for Continuing Education. "Our aim is clear: we want to provide an attractive, high-quality offering. In order to do so, we're creating new structures and improving collaboration within ETH."

The new school and the targeted expansion of the course – around 20 new continuing education programmes are in preparation – are intended to improve the visibility of ETH's continuing education opportunities. One of ETH Zurich's core tasks is to educate and train specialists in scientific and technical fields. But in addition, the university sees its continuing education programme as a "means of cultivating relationships with industry and society," as Ermanni describes the transfer of knowledge from academia to practice.

ETH hopes that the new School for Continuing Education will enable it to react more flexibly to the needs of the labour market. Since autumn 2018, the university offers two new continuing education programmes in the field of cybersecurity. The DAS Cyber Security is aimed at professionals who already have IT training. Course participants learn the basics of information security and discuss current results and insights offered by research. The CAS Cyber Security targets a broader audience, which explicitly includes non-IT specialists. The course is aimed at people who deal with questions of information security in their day-to-day work and want to acquire a well-grounded basic knowledge of the relevant issues.

Close connections with industry are a key part of the School for Continuing Education. For example, a customised continuing education programme has been created in dialogue with industry at the Competence Center for Materials and Processes. It is tailored to the experience and interests of one or more course participants. During their ETH Sabbatical, industry professionals can work on a scientific question in a research laboratory. They have access to a professor from ETH Zurich who acts as their mentor.

Seventy groups are currently taking part in this continuing education programme. The customised programme is an excellent example of how the School for Continuing Education combines the latest knowledge with critical thinking and practical problem-solving skills. The teaching and learning formats applied in continuing education courses not only promote the exchange of knowledge and experience, they also facilitate networking. In the future, Ermanni hopes that the School of Continuing Education will continue to "implement exciting new programmes that build on the expertise of ETH Zurich and are relevant to industry and society." The more people ETH is able to attract to its continuing education programmes, the more the social benefits of the knowledge gained at ETH will grow. ■

www.ethz.ch/continuing-education-press-release
www.ethz.ch/continuing-education

Challenge the best – ETH Zurich's campaign for continuing education.

Students and degree awards

Students	Total		Bachelor's		Master's		Doctoral		MAS/MBA students		Visiting/exchange students	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Headcount	**20,607**	**21,397**	**9,262**	**9,517**	**6,158**	**6,590**	**4,092**	**4,175**	**646**	**635**	**449**	**480**
Percentage women	31.8%	32.3%	31.2%	32.7%	31.6%	31.0%	31.7%	32.1%	41.0%	43.1%	36.1%	30.8%
Percentage international students	38.7%	39.4%	19.9%	20.4%	40.7%	41.6%	71.4%	72.9%	41.8%	40.6%	94.7%	93.5%
Total registrations	**21,102**	**21,886**	**9,671**	**9,922**	**6,166**	**6,608**	**4,092**	**4,175**	**724**	**701**	**449**	**480**
Architecture and Civil Engineering	3,587	3,574	1,674	1,723	1,258	1,209	437	422	127	125	91	95
Engineering Sciences	7,430	7,825	3,547	3,650	2,280	2,546	1,405	1,443	18	22	180	164
Natural Sciences and Mathematics	5,307	5,469	2,511	2,480	1,346	1,505	1,144	1,165	209	197	97	122
System-oriented Natural Sciences	3,828	4,085	1,889	2,026	939	1,008	836	865	115	118	49	68
Management and Social Sciences	950	933	50	43	343	340	270	280	255	239	32	31
New students	**7,446**	**7,688**	**2,918**	**2,937**	**2,544**	**2,739**	**993**	**991**	**292**	**261**	**699**	**760**
Architecture and Civil Engineering	1,241	1,145	424	463	502	381	110	97	90	61	115	143
Engineering Sciences	2,627	2,785	1,046	1,071	935	1,089	343	331	8	10	295	284
Natural Sciences and Mathematics	1,901	1,994	842	766	595	721	258	273	48	52	158	182
System-oriented Natural Sciences	1,317	1,444	593	626	389	452	207	220	40	37	88	109
Management and Social Sciences	360	320	13	11	123	96	75	70	106	101	43	42
Country of education												
Switzerland	13,921	14,278	8,373	8,544	3,838	4,059	1,220	1,178	461	458	29	39
EU	4,847	5,082	1,099	1,167	1,428	1,528	1,901	1,969	157	144	262	274
Rest of Europe	516	572	114	126	179	215	179	189	20	15	24	27
Asia	1,207	1,330	56	56	504	577	508	557	52	48	87	92
America	479	487	23	23	170	177	228	225	25	25	33	37
Africa	83	98	4	5	28	36	43	49	5	6	3	2
Australia and New Zealand	49	39	2	1	19	16	13	8	4	5	11	9

Degrees and diplomas	Total		Bachelor's		Master's		Doctoral		MAS		Teaching diploma/MAS SHE		Teaching certificate	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Degrees	**4,777**	**4,957**	**1,606**	**1,678**	**2,072**	**2,196**	**827**	**802**	**182**	**184**	**62**	**48**	**28**	**49**
Architecture and Civil Engineering	918	844	373	281	381	410	79	94	85	59	0	0	0	0
Engineering Sciences	1,545	1,655	537	607	733	786	265	250	0	0	4	2	6	10
Natural Sciences and Mathematics	1,183	1,264	365	425	506	559	268	238	4	14	40	25	0	3
System-oriented Natural Sciences	896	942	318	349	355	359	170	172	13	5	18	21	22	36
Management and Social Sciences	235	252	13	16	97	82	45	48	80	106	0	0	0	0

www.ethz.ch/student-stats

ETH AS A TALENT FACTORY

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.

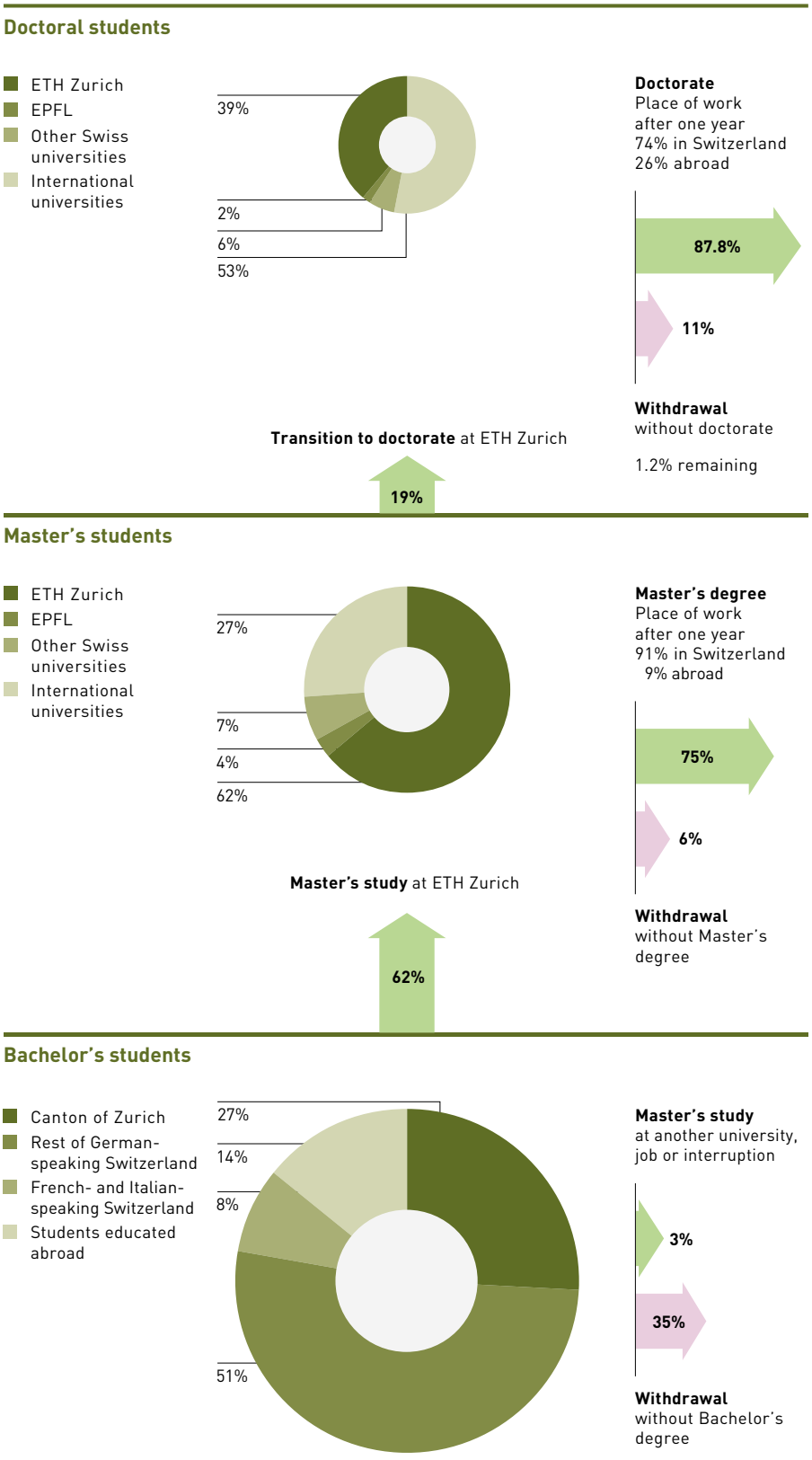
Most ETH students who finish their Bachelor's degrees then carry on to a Master's course at the university, with 95 percent following this progression. They account for around two thirds of all Master's students. A quarter of students come from international universities, with more than 4,000 students 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 four semesters for students without a Bachelor's degree from ETH. Students on Master's programmes 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 Zurich.

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. Three quarters of doctoral students are employed as scientific staff at ETH.

Almost 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 doctorates.



Student data based on the average for the period 2013–2018; study success: matriculation cohorts 2007–2012 (Bachelor's, doctorate) or 2008–2013 (Master's); study duration: graduating cohorts 2013–2017; graduates' place of work one year after completing their studies: average of graduates of the years 2012, 2014 and 2016 from the FSO graduate survey

GROWTH OF STUDENT NUMBERS

The number of ETH students is growing and so is the percentage of women

With 21,397 new students, ETH Zurich is seeing further strong growth in student numbers across all levels (Bachelor's and Master's, doctoral, continuing education, visiting and exchange students). This represents a 3.8 percent increase on the previous year.

While the number of new students enrolling in Bachelor's programmes changed only slightly compared with the previous year (+0.7 percent), the number of new students enrolling in Master's programmes increased by 7.7 percent compared with 2017. It is noticeable that the number of women entering the Bachelor's programme increased by 7 percent, while the number of men decreased by 2.5 percent. As a result, the percentage of female students enrolling in undergraduate degree programmes rose to over 35 percent.

For those students enrolling in Master's programmes, the picture was reversed, with the number of men increasing by 12.6 percent and women declining by 2.5 percent. There was a notable increase in the number of students from outside ETH enrolling in Master's courses (up by 14.5 percent, a similar rise to 2016).

The percentage of students with foreign entry qualifications is increasing among new students: this is true of Bachelor's and Master's students (up by 1 and 2 percentage points respectively) as well as doctoral students (up by 3 percentage points).

The total number of students who enrolled in undergraduate courses was 0.7% up on the previous year. With 434 new students, Mechanical Engineering remains the most popular undergraduate course, although the upward trend of recent years has slowed, with a fall of 9 percent compared with the previous year. The number of undergraduates studying Computer Science continued to grow strongly, up by 15 percent on the previous year, making the Computer Science Bachelor's programme the second most popular course, with 374 new entrants. Architecture (with 262 new entrants) and Health Sciences (219) also recorded an increase, while Physics with 216 new entrants is attracting fewer students (down by 11 percent).

Most ETH Bachelor's graduates (95 percent) continue their studies on one of the ETH Master's programmes.

The student–faculty ratio has deteriorated slightly over the years, due to rising student numbers. In 2018, one professor on average supervised 43.5 students from all categories (2000: 32; 2008: 39). ■

www.ethz.ch/academic-services

MAS ARCHITECTURE AND DIGITAL FABRICATION

Wooden pergola made by robots provides a shady spot

The large roof terrace of the Istituto Svizzero in Rome was almost unusable, being exposed to scorching sun. But now it has a shady wooden pergola. It was created by students taking the MAS course in Architecture and Digital Fabrication. The study project gave them an overview and understanding of electronic planning and construction processes.

The structure requires no glue, nails or screws. Wood-to-wood joints were common in the Middle Ages, but were superseded by industrial construction methods. Now, thanks to robotic manufacturing, they are back in the limelight. The students designed a system of 700 wooden elements on screen and then produced it within three weeks in the Robotic Fabrication Laboratory at ETH Zurich. In Rome, the students assembled the elements by hammering in 2,700 wooden dowels that had previously been shrunk in an oven. Once the dowels were in the digitally positioned holes, they merely had to be moistened and allowed to swell, turning the terrace into a pleasant spot. ■

www.ethz.ch/wooden-pergola

The pergola's structure requires no glue, nails or screws.

ETH IN DIALOGUE

School partnerships

Through a variety of projects, ETH Zurich is helping schools find more scope to develop their own ideas, besides teaching facts and methods.

Juraj Hromkovic, Professor of Information Technology and Education, begins his entry in ETH Zurich's Zukunftsblog with a story: Martha had never stood out as a pupil until Year 6, when she took part in the Programming in School project. Martha set to work enthusiastically and not only completed the tasks in no time, she also helped the other pupils to solve the problems, because she could explain the programming tasks even better than the teacher. In the subsequent programming competition she not only solved all the tasks correctly, but also completed three tricky additional ones. No child had ever managed that before, and that was how Martha's exceptional talent was recognised.

Professor Hromkovic is the head of teacher training for the computer science teaching diploma at ETH. In 2005, he founded a training and advice centre for computer science teaching, where projects such as Programming in Schools are developed. To date, some 12,000 children in more than 200 schools throughout Switzerland have taken part. Professor Hromkovic says that his team came across "enthusiastic children, driven by a sense of achievement as they develop their own functional products by themselves."

The aim of the Lernfeld project, which is based at the Institute of Agricultural Sciences, is to introduce pupils between Year 5 and their final year at secondary school to scientific working methods and approaches. The youngsters explore the role of agriculture in relation to biodiversity and climate change, guided by graduate students who gain teaching experience in the process. As with real research, the pupils have to formulate a hypothesis which they then test through meticulous observations. Back in the classroom afterwards, they evaluate the data that they collected in the field. Finally, they present their findings to experts and fellow pupils and put their conclusions forward for discussion. ■

The pupils compared plant diversity in heavily and lightly used farmland.

During the field trip, the pupils observed insects visiting flowers.

www.ethz.ch/blog-computer-science-education
www.ethz.ch/lernfeld-campaign

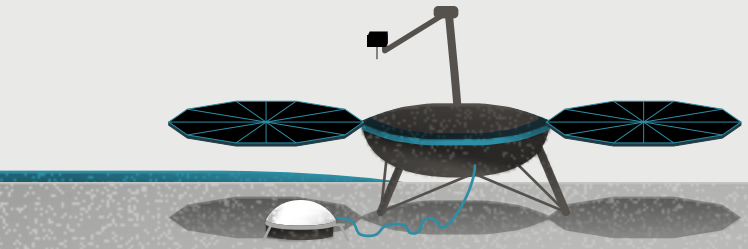
DUCKIETOWN TEACHING PROJECT

Automated driving with rubber ducks

In the Duckietown teaching project, students from ETH Zurich, along with others from Montreal and Chicago, operate a fleet of small, self-driving vehicles. Each of the "Duckiebots" has a trademark rubber duck on board. The vehicles navigate streets marked out with adhesive tape. What looks like child's play is based on highly complex systems in which hardware components, sensors and motors have to work in harmony. The participants work in teams composed of students from three universities and spend a semester working on a particular aspect of these interactions. The greatest challenges are often not theoretical, but practical, such as low-angle sunlight which tends to put the robots off course. In the Duckietown project, students learn to deal with the fact that there are no perfect systems in robotics. The solutions that the students work out are made freely available, and the code that controls the Duckiebots is open source, thus enabling enthusiasts all over the world to benefit from this pioneering work. There are also key benefits for the students. By demonstrating that they can coordinate their project and deliver it under time pressure, they meet their learning objectives and at the same time acquire a skill that is in great demand in industry. ■

www.ethz.ch/duckietown-news

Fundamental research as the basis for future innovation



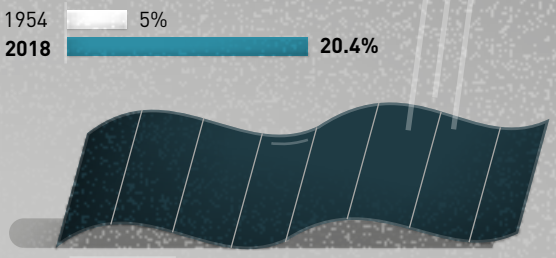
A universe of inspiration

1855: Astronomer Rudolf Wolf founded ETH Zurich's long tradition of solar research. Gottfried Semper built the old Swiss National Observatory according to Wolf's specifications.
2009: ETH researchers developed key components of one of the main measuring instruments on board the ESA's Herschel Space Observatory.
Today: The ESA's Swiss Business Incubation Centre (ESA BIC Switzerland) is now located at ETH Zurich. It supports start-up companies involved in space technologies.

Harnessing the power of the sun

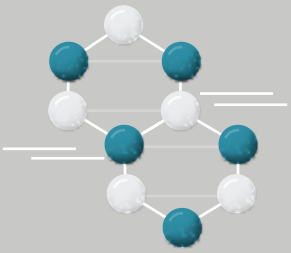
1905: Albert Einstein laid the foundations for understanding solar cells with his theoretical explanation of the photoelectric effect.
1954: The first solar cell was created in the US with an energy conversion efficiency of around 5 percent.
Today: Researchers from ETH Zurich and Empa produce flexible thin-film solar cells with a world-record-breaking efficiency of 20.4 percent.

Conversion efficiency of solar cells:



Brilliant minds in the world of computing

1946: The mathematician Eduard Stiefel, who founded the Institute of Applied Mathematics at ETH Zurich, laid the foundations of computer science in Switzerland.
1968–1972: ETH Professor Niklaus Wirth developed the Pascal programming language, which shaped computer science education for years to come.
Today: Global companies such as Disney and Google are attracted to Zurich by the reputation of ETH Zurich and its graduates.



Synthetic materials

Around 1900: The triumphant advance of synthetic materials began.
1922: ETH Professor Hermann Staudinger coined the term macromolecular compounds. His concept laid the foundation for the production of synthetic materials.
Today: ETH Professor Nicola Spaldin develops entirely new materials called multiferroics: crystalline compounds that respond to both electric and magnetic fields.

Imaging the inside of the body

1946: Two researchers working independently of each other, Edward Purcell at MIT and ETH alumnus Felix Bloch at Stanford, discovered the phenomenon of magnetic resonance.
1960s: ETH Nobel Prize winner Richard Ernst developed Fourier transform (FT) NMR spectroscopy, which helped achieve a breakthrough in nuclear magnetic resonance spectroscopy.
Today: Research conducted at ETH and the University of Zurich has now made it possible to take real-time images of a beating heart and reconstruct individual nerve fibres in the brain.

Research

ETH Zurich values basic research as the key to expanding its knowledge base and laying the foundation for future innovations. Here the university's activities focus on the broad fields of medicine, data, sustainability and manufacturing technologies.

Healthcare was a particularly active area of research in 2018. Two initiatives for promoting personalised medicine, along with a new research centre for child health co-founded with the University of Basel, are helping to advance medical research. A third of ETH professors from different departments are directly or indirectly involved in medical research.

One highlight of 2018 was the successful InSight mission landing on Mars. A seismometer fitted with electronics developed at ETH Zurich records and transmits data from the Red Planet. Analysis of this data will provide vital information on the structure and composition of Mars and could even give new insights into the origin and development of our solar system.

MEDICINE

A strong commitment to healthcare

ETH Zurich continues to contribute to the improvement of healthcare and is involved in two key initiatives to promote personalised medicine. It has also joined forces with the University of Basel to establish a new centre for research into child and adolescent health.

As a leading university for science and technology, ETH Zurich has been making a significant contribution to advancing medicine for several decades. This is evident not only in its basic research and the development of diagnostic and therapeutic technologies, along with their transfer into practical and clinical applications, but in its ongoing commitment to teaching, training and continuing education. Detlef Günther, Vice President for Research and Corporate Relations, is proud of the university's strong track record: "ETH has been working extensively and successfully in the broad field of medicine for a long time. It is a key area of focus for us, and one we intend to pursue in future."

A third of ETH's professors in different departments are directly or indirectly involved in medical research. ETH Zurich is well aware, however, that modern medical research cannot be carried out in isolation. ETH researchers therefore work closely with medical faculties at other universities, as well as hospitals and clinics. Personalised medicine in particular requires researchers to work together across disciplines and institutions.

The Botnar Research Centre for Child Health combines the expertise of ETH Zurich and the University of Basel in top-level research into child and adolescent health worldwide.

New initiatives launched

ETH is also actively involved in two new Swiss initiatives launched in March 2018 to promote personalised medicine. The university plays a leading role in the ETH Board's Personalized Health and Related Technologies (PHRT) initiative, for example, whose goal is to improve prevention and treatment through individually tailored medical interventions. The PHRT is an extension of the Swiss Personalized Health Network (SPHN) launched by the State Secretariat for Education, Research and Innovation. The SPHN is a national initiative tasked with creating the framework for the exchange of health-related data between universities and clinics.

"The aim of both initiatives is to foster collaboration between all the various medical research institutions and facilitate the exchange of data," Günther explains. "One of the goals, for example, is to get Swiss hospitals and clinics to define a minimum amount of data that they will agree to enter for certain pathologies that can then be correlated across all the different hospitals. The idea is to make this information available in electronic dossiers, so we can link it to other data such as genomics and proteomics databases." To get some initial data moving into the research space as quickly as possible, "driver projects" have been defined for certain diseases, such as cancer.

Research centre in Basel

In September 2018 the University of Basel and ETH Zurich co-founded the Botnar Research Centre for Child Health (BRCCH) in Basel. The BRCCH received 100 million Swiss francs in funding from the Fondation Botnar in Basel. This pledge of support for the BRCCH represents a major investment for the foundation, originally established in 2003 to improve the health and well-being of children and adolescents in fast-growing cities worldwide. The research centre combines the expertise of both universities in systems biology and medicine, as well as in various areas of life sciences, engineering, social sciences and information technology, that are relevant to health. The work of the BRCCH will help to prevent diseases, develop new treatment approaches, improve diagnoses and effectiveness forecasts, and make healthcare systems more affordable.

The BRCCH will target four main areas of paediatric research in particular: diabetes, infectious diseases/immunology, cardio-respiratory diseases, and the restoration of bodily functions through regenerative surgery. The focus will be on approaches geared to digital and mobile healthcare solutions and to cell-based therapies. Lino Guzzella, ETH President up to the end of 2018, comments: "Our goal is to develop groundbreaking digital solutions to improve the health of children and adolescents." The research centre began operations in Basel in January 2019. ■

www.sfa-phrt.ch
www.sphn.ch
https://www.brcch.org/en/
www.ethz.ch/the-future-of-medicine
www.ethz.ch/personalised-medicine
www.ethz.ch/news-brcch

TRANSPORT SYSTEMS

New mobility initiative

ETH Zurich launched the ETH Mobility Initiative together with Swiss Federal Railways (SBB) in January 2018. The aim is to significantly expand research and teaching in the field of mobility, including the creation of new professorships.

Congested roads, packed trains and extra buses during rush hour: existing transport systems are being stretched to their limits. Technological progress is enabling new solutions, from self-driving vehicles and more efficient use of road and rail infrastructure to door-to-door mobility. Meeting the numerous challenges and creating marketable innovations requires the cooperation of the scientific, economic and public-transport sectors. ETH Zurich and the SBB are responding to the challenge by launching the ETH Mobility Initiative.

"With this initiative, we aim to further expand our activities and expertise in this promising area and establish ETH Zurich as a leading centre for mobility research, both nationally and internationally," says former ETH President Lino Guzzella. SBB CEO Andreas Meyer adds: "This collaboration will allow us to take full advantage of the opportunities offered by the digital transformation – to improve people's quality of life and the attractiveness of Switzerland as a location."

Research in the ETH Mobility Centre

More than 20 research groups already work in various areas of mobility research at ETH Zurich. Over the next ten years, this specialist expertise will be expanded with the introduction of two to four new professorships. Up to 100 doctoral students and postdocs will also conduct research into mobility-related questions. In the new ETH Mobility Centre, ETH specialists will work with funding partners on technological innovations, such as the development of nationwide mobility simulations.

The first 10 years of the project will require around 100 million Swiss francs in funding. Funding partners will cover roughly half these costs, and ETH Zurich will provide the remainder. ■

www.ethz.ch/mobility-initiative

INSIGHT MISSION

ETH electronics used to measure "marsquakes"

NASA's InSight space probe landed on the Red Planet in November 2018. It carried a seismometer deploying sophisticated electronic instruments developed at ETH Zurich.

Many researchers had been looking forward to this moment with great excitement: on 26 November 2018 the InSight space probe landed on Mars. "We've been working towards this moment for almost 20 years," says Domenico Giardini, Professor of Seismology and Geodynamics at ETH Zurich. He headed the ETH team that was part of the InSight mission.

Scientists developed the InSight lander to examine the crust, mantle and core of the Red Planet – a project that also brings the Swiss flag and the ETH logo to Mars for the very first time. Dedicated control and data acquisition electronics used in the lander's seismometer, called the Seismic Experiment for Interior Structure (SEIS), record seismic activity and vibrations caused by meteorite impacts, allowing scientists to explore the planet's interior.

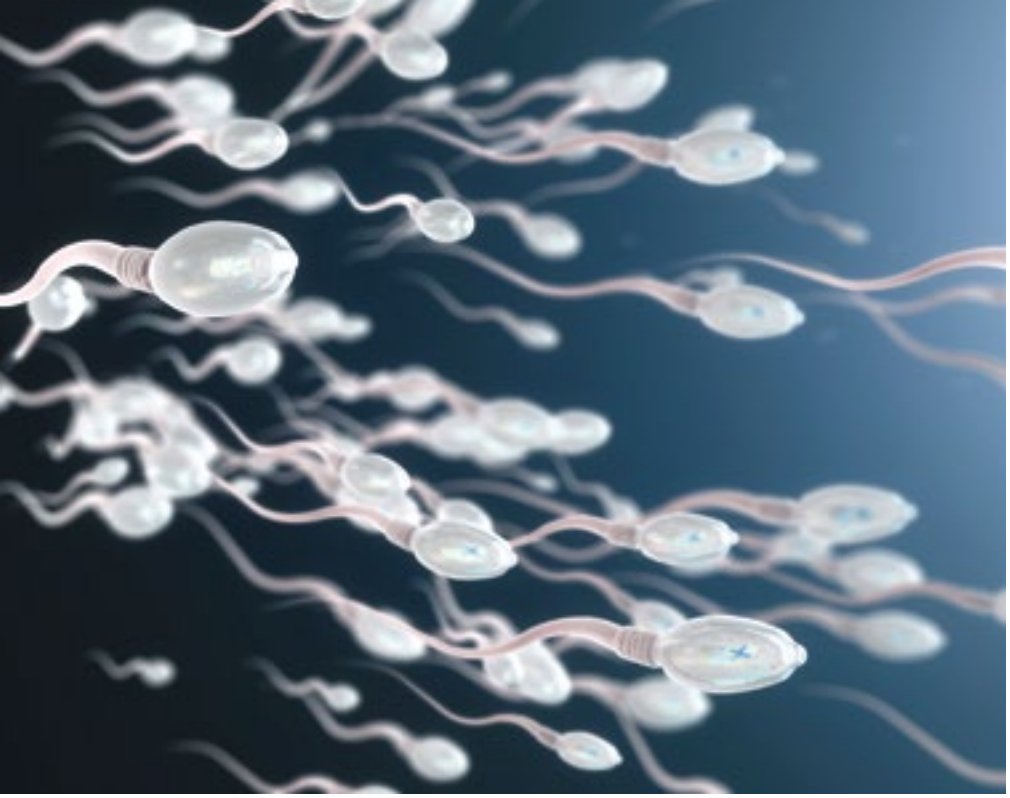
ETH will be first to interpret the data

The first test data are due to reach the Earth in early 2019. Because of the huge distance between Mars and Earth, data transmission takes about 20 minutes. After the NASA Deep Space Network collects the data and the French space agency CNES performs a preliminary evaluation, the ETH Marsquake Service will analyse them as part of their daily work in order to record and then localise any tectonic activity and meteorite strikes. The ETH group will also be the first to interpret the data. Data analysis will continue for at least two years.

The seismometer records the signatures of waves that are repulsed or deflected in different layers of Mars's interior, as well as those caused by meteorite impacts or seismic activity. This in turn allows scientists to draw conclusions about the structure and composition of the Red Planet. They also hope to make new discoveries about comparable processes on Earth, as well as about the origin and development of planets in our solar system. ■

www.insight.ethz.ch

The InSight lander positioned its seismometer on the surface of Mars in late December.



Sperm carry information as to whether they were produced during a cold period.

HEALTH SCIENCES

Cold leads to slimmer offspring

Exposure to cold prior to conception causes the resulting offspring to have more brown adipose tissue, which protects against excess weight and metabolic disorders. Scientists studying mice have discovered that this information is passed on by sperm, and there is a similar correlation in humans.

Brown adipose tissue helps to use up excess energy. In some people this brown fat is found under the tongue, around the collarbone and along the spine. The more brown fat someone has and the more active the fat is, the lower their risk seems to be of becoming overweight or developing metabolic disorders.

An international research team led by ETH Professor Christian Wolfrum has now shown that one key variable in the formation of brown adipose tissue is set before conception: males who spend time in low temperatures prior to mating will produce offspring with more active brown adipose tissue. The researchers reached this conclusion by studying mice.

In humans, too, there is a correlation between the ambient temperature before conception and the prevalence of brown fat. Together with colleagues at the University Hospital Zurich, the ETH scientists analysed computed tomography images of 8,400 adult patients. They noted that people conceived in the winter months have significantly more active brown adipose tissue than those conceived during the summer.

To follow up on this correlation, the researchers conducted studies in mice. They kept the animals at either a moderate 23° Celsius or a cool 8° Celsius and allowed them to mate. An analysis of the results showed that the offspring of males kept in a cool environment for several days prior to mating had more active brown adipose tissue than those of males kept in a temperate environment. In addition, the offspring of males kept in cool conditions were better protected against excess weight and metabolic disorders.

The results that the ETH scientists obtained from their studies of mice and men concur with earlier observations that people in cold regions have particularly high levels of brown adipose tissue. "Until now, the assumption was that this had something to do with the temperatures people experienced during their lifetime," Wolfrum says, "but our observations suggest that temperatures prior to conception might also affect later levels of brown fat." ■

www.ethz.ch/passing-environmental-impact

CLIMATE RESEARCH

Warmer temperatures bring heavier rainfall

ETH researchers from the Chair of Hydrology and Water Resources Management have shown how air temperature can affect when and where extreme rainfall occurs. Led by postdoctoral researcher Nadav Peleg, the team deployed the ETH mainframe computer Euler to examine an unusually long series of data measurements from an Israeli weather radar system. Meteorologists used this radar system to make continuous measurements – which also had very high temporal and spatial resolutions – of rainfall in the eastern Mediterranean region over a period of 25 years. The researchers based their analyses on rain measurements within a range of 5 to 25 degrees Celsius, that is to say, temperatures typical of the eastern Mediterranean region in spring and autumn.

Peak intensities are increasing

From their analyses, the ETH researchers were able to confirm that in the eastern Mediterranean region the peak intensity of extreme rainfall increases at higher temperatures. However, at 4.3 percent per degree Celsius, this increase is lower than assumed. According to a physical principle, rain intensity worldwide increases on average by 7 percent for every 1 degree Celsius of temperature rise.

ETH scientists also established that the area of individual rainfall cells often became smaller at higher temperatures, and that rainfall was distributed differently: convective processes shift the moisture available in the atmosphere from areas with low rainfall intensity to areas with high rainfall intensity. "In a warming climate, there is therefore a higher risk of local flooding," Peleg explains.

He considers the findings important for policy and decision-makers. In general, extreme precipitation in the eastern Mediterranean region is likely to intensify. "The research results help to better assess the impact of the future climate on water availability or natural hazards – particularly the risk of local storms and flooding," the weather researcher concludes. ■

www.ethz.ch/convective-rain-cells

THEORETICAL PHYSICS

Searching for errors in the quantum world

Quantum mechanics is a well-supported scientific theory. However, a thought experiment has produced unexpected contradictions: Renato Renner, Professor for Theoretical Physics, and his former doctoral student Daniela Frauchiger considered a hypothetical physicist examining a quantum mechanical object. Using quantum mechanics, they then calculated what the physicist would observe. This indirect observation should yield the same result as direct observation, yet the pair's calculations showed that the prediction as to what the physicist will observe is exactly the opposite of what would be measured directly, creating a paradoxical situation.

The experiment has been the topic of much discussion among experts, who have questioned the calculations but failed to disprove them so far. "We are now checking whether our thought experiment assumes things that shouldn't be assumed in that form," Renner says. "Perhaps this will give us some ideas on how we can continue to develop quantum mechanics." ■

www.ethz.ch/errors-in-the-quantum-world

What does a physicist see when examining a quantum object? The same as the person observing the physicist – or exactly the opposite?

ELECTRICAL ENGINEERING

Smart transformer for the energy revolution

ETH Zurich electrical engineers in Professor Johann Kolar's research group have developed a smart electronic transformer that is very efficient at transforming medium-voltage into low-voltage electricity. Smart transformers of this kind are much smaller than standard transformers and are therefore particularly suitable for use wherever space is limited or weight must be kept to a minimum, as is the case in rail locomotives, for example. Most power grids for rail applications supply alternating current at medium-voltage level. The locomotives then step the voltage down to a lower value.

Smart transformers have a trick up their sleeve. First, a front-end converter greatly increases the frequency of the alternating current, meaning the transformer itself can be much smaller. Then a subsequent converter produces alternating current at the desired frequency.

Potential applications for the transformer range from locomotives to fast charging stations for electric vehicles and power supplies for data centres, or they could be used in the smart power grids of the future. ■

www.ethz.ch/smart-transformer

POLITICAL ANALYSIS

More job opportunities for refugees

An algorithm could increase employment levels for asylum seekers in Switzerland from 15 to 26 percent. It could also improve canton allocation. This is the conclusion of a new study published in collaboration with ETH's Public Policy Group.

Asylum seekers and refugees with subsidiary protection are allowed to work in Switzerland – but only in the canton to which they are assigned during the asylum process. This allocation is based on politically defined parameters: for example, a canton's population is taken into account, and efforts are made to allocate nationalities equally across all cantons. Factors such as labour market integration and the asylum seekers' employment prospects are not considered. One consequence is that, on average, just 15 percent of refugees are employed by their third year in Switzerland.

Political scientists from Stanford University and ETH Zurich found that if the canton allocation were better tailored towards the refugees' integration into the labour market, their level of employment could be 73 percent higher than it currently is. By their third year in Switzerland, 26 percent of refugees could be working.

The scientists' data-driven approach is based on an algorithm that they developed using machine learning methods. This algorithm can identify those cantons where the personal attributes and abilities of particular refugees (e.g. age, gender, origins, language) best fit the characteristics of the labour market (e.g. size of the agricultural sector, language region, ethnic networks). The algorithm uses existing data from the State Secretariat for Migration.

"The next step could be to put the algorithm into practice; it would be fairly straightforward to integrate it into the existing allocation process," explains Dominik Hangartner, Professor of Public Policy at ETH Zurich, who is responsible for the Swiss part of the study. He adds that it could also be updated at any time if the composition of refugees and labour market were to change. ■

www.ethz.ch/employment-opportunities-for-refugees

PHARMACEUTICALS

Easier way to search for new drugs

ETH researchers led by Professor Dario Neri have developed a new screening method that provides a much more efficient way to search for drugs. At the centre of the method is a new DNA-encoded chemical library (DECL) containing millions of different drug candidates.

Each of the candidates contained in the collection consists of a stable, ring-shaped basic structure. The chemist then attached three different small molecules to one side of each ring. "Together, they form a kind of highly specific 'fish hook' that can bind on to a protein if its form perfectly matches the protein's structure," says Jörg Scheuermann, who is currently working in Neri's group. Researchers used hundreds of such molecules, combining them in various ways to create a library of around 35 million different fish hooks.

Many tested at once

With their chemical collection, the researchers could then start fishing: to find out if one of the fish hooks would catch the target protein, the researchers put the whole collection of 35 million compounds into a reaction vessel containing the protein on a carrier. After a certain time, the researchers washed the chemical collection away. All the drug candidates that stuck to the protein remained in the sample. This meant the researchers could easily test the whole batch for potential matches in one go. ■

www.ethz.ch/drug-candidate-examination

MECHANICAL ENGINEERING

3D-printed motorless submarine

Using nothing but 3D printing, scientists have developed a paddling mini-submarine that requires no engine, propellant or power supply. This technology could provide a low-power means of exploring the ocean depths.

Researchers at ETH Zurich under the direction of ETH Professor Kristina Shea, working with colleagues at Caltech in California, have developed a new propulsion concept for swimming robots. The robot exploits temperature fluctuations in the water for propulsion without the need for an engine, propellant or power supply.

The researchers developed a 7.5-centimetre mini-submarine equipped with paddles, which they fabricated entirely using a 3D printer. The paddles are actuated using a bistable propulsion element triggered by two shape memory polymer strips which act as the robot's "muscles". They are designed to expand in warm water. If the water surrounding the mini-submarine is heated, expansion of the "muscles" causes the bistable element to quickly snap, triggering a paddle stroke. The directional motion, force and timing of the paddle strokes are precisely defined by the robot's geometry and material.

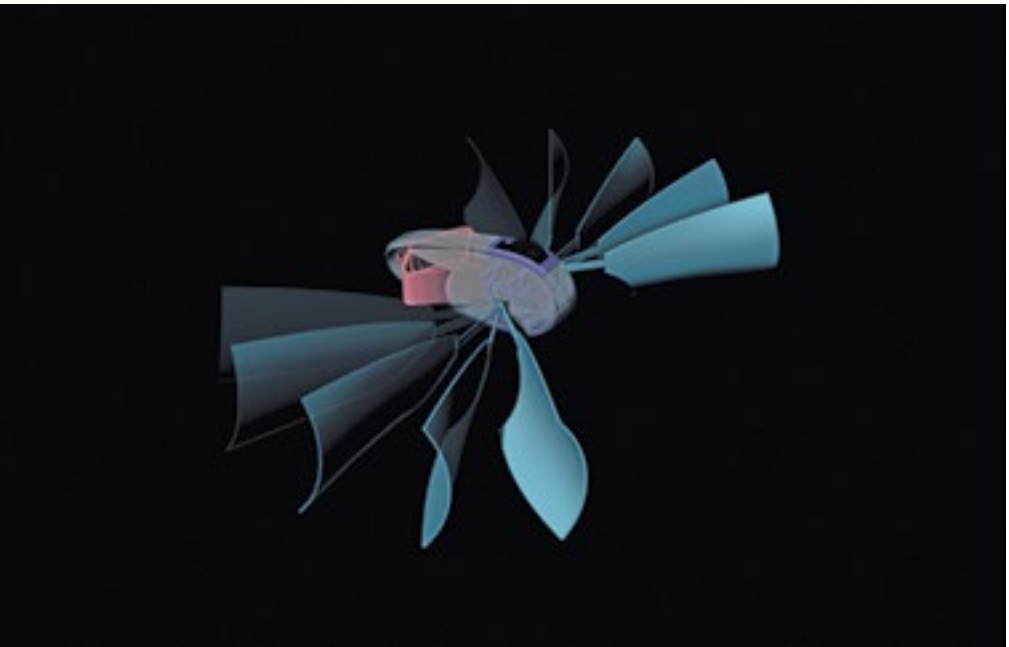
At present, each actuating element can execute a single paddle stroke and must then be reprogrammed manually. However, as the scientists point out, it is possible to fabricate complex swimming robots with multiple actuators. They have already made a mini-submarine that can paddle forward with one stroke, release its "cargo" (a coin) and then navigate back to the starting point with a second paddle stroke in the opposite direction. Varying the geometry of the polymer muscles allowed the scientists to define the sequence in which the paddle stroke is triggered: thin polymer strips heat up faster in warm water and therefore respond faster than thicker ones.

A potential development would be to use polymers that do not react to water temperature, but to other environmental factors such as the acidity or salinity of the water.

"The main takeaway from our work is that we have developed a new and promising means of propulsion that is fully 3D printed and works without an external power source," says Shea. This could be developed further to create a low-power vessel for exploring ocean depths. ■

www.ethz.ch/swimming-without-an-engine

Visualisation of a simple mini-submarine with two paddles.



The wing of an earwig opens from a central mid-wing joint with no need for muscle power to provide stability.

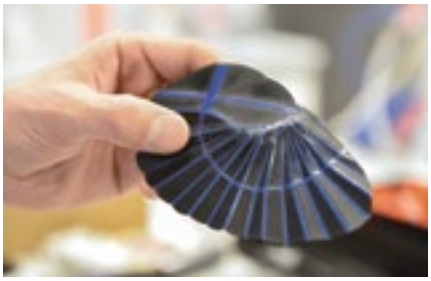
MATERIALS SCIENCE

Foldable structures from a 3D printer

ETH Zurich researchers have developed multifunctional origami structures, which they then produced with a 3D printer. The underlying design principle draws from nature, by mimicking the structure of an earwig's wing.

The origami design could be used for foldable electronics.

The skill of the art of origami lies in folding a flat sheet of paper into different – and in some cases highly complex – structures. Examples of origami also exist in the natural world. The wing of an earwig is a perfect illustration: when expanded it is more than ten times bigger than when closed, but in its open, locked state the wing remains stiff and folds into itself with just one "click". None of this requires muscle power.



The 3D-printed replica of the earwig wing folds into a compact form.

The scientists have created an artificial structure that functions on the same principle. To analyse the wing structure and function, Jakob Faber from the research group led by ETH Professor André Studart, in collaboration with Professor Andres Arrieta of Purdue University, performed a computer simulation of the wing's function.

The researchers transferred the findings of the computer simulations to a multimaterial 3D printer. This allowed them to directly manufacture a so-called 4D object comprising four stiff plastic plates connected to each other by a soft elastic joint.

The wing is stable when open, but folds together automatically on even the lightest touch. In the next step, the researchers transferred the principle to larger elements and printed a spring origami gripper. This structure self-folds, locks and is then able to grip objects.

Faber's 3D printed, self-folding origami elements are currently only available as prototypes. One potential application might be foldable electronics. Another area is space travel: solar sails for satellites or space probes that could be transported within a very small space and then unfurled to their full size at their place of use. ■

www.ethz.ch/earwig-origami

MICROBIOLOGY

New antibiotics from leaf-dwellers

A team of ETH researchers have discovered new antibiotic substances in bacteria that colonise the leaf surfaces of a native wild plant.

A wide variety of microorganisms, such as bacteria and fungi, live on the leaves of plants. In an effort to keep the competition at bay, many of the leaf dwellers turn to chemical warfare: they develop antibiotic substances.

During a systematic search of the leaves of thale cress *(Arabidopsis thaliana)*, a group of researchers led by ETH Professors Julia Vorholt and Jörn Piel from the Institute of Microbiology have now discovered a remarkably chemically productive bacterium: *Brevibacillus* sp. Leaf 182. In experiments, it inhibited half of the 200 strains that the researchers had isolated from the leaf surfaces. The bacterium produces and secretes at least four antibiotic chemical compounds. One of these, macrobrevin, presented a previously unknown chemical structure.

Macrobrevin might be effective against bacteria that cause human diseases.

The aim of the project was to find new antibiotics in a previously unexplored habitat. "Until now, research has focused specifically on soil as a habitat; but now we keep finding the same substances there," says Vorholt. The search for new antibiotics is thus becoming more and more difficult. "We hardly have any antibiotics left that at least one pathogen is not resistant to," Piel warns. "We will now determine whether macrobrevin and other newly discovered substances are also effective against bacteria that cause diseases in humans." But he feels it is a great achievement in itself to have shown that there are still many natural antibiotic substances waiting to be discovered in the microcosms of leaf surfaces. ■

www.ethz.ch/leaf-surface-antibiotics

The Bay of Naples with the island of Ischia (left) and the scarred Phlegraean Fields. Naples lies at the foot of Mount Vesuvius (centre).

VULCANOLOGY

Identifying volcanic cycles

The Phlegraean Fields in the west of Naples have entered the first stage of a new caldera cycle. This is the conclusion volcanologists have reached using rock analysis and modelling.

The Phlegraean Fields near Naples are one of the world's most active volcanic regions. Its craters, or "calderas", were formed by enormous eruptions that took place 39,000 and 15,000 years ago.

A team of volcanologists, led by then ETH doctoral student Francesca Forni and Professor Olivier Bachmann of ETH Zurich, have discovered that the Phlegraean Fields are subject to caldera cycles. The region is currently at the early stage of a new cycle that could culminate in another gigantic eruption.

A cycle begins with the accumulation of magma in a large reservoir in the earth's crust, a process that takes millennia. This stage is characterised by long periods of dormancy and minor eruptions. A further injection of magma into the magma chamber triggers a massive eruption. The reservoir empties abruptly, the roof collapses, and a new caldera is formed – the cycle begins anew.

Rock samples from earlier eruptions at the Phlegraean Fields provided the researchers with evidence of the start of a new cycle. The chemical composition of minerals in magmatic rock can provide information on the conditions under which they formed. A comparison of the chemical signatures of rock from different eras enables volcanologists to reconstruct the conditions in the crust at the time of its formation. This allows them to determine the current stage of the magma system. The volcanologists also created a model of the cycle.

"This study is important because we can reconstruct the rhythm of super volcanoes from past eruptions," explains ETH Professor Bachmann. In principle this is possible for any super volcano on the planet. "We can also hopefully predict where they stand in their cycle."

Despite these advances, the researchers cannot predict when the next major eruption at the Phlegraean Fields may occur. But Forni is confident: "We are unlikely to experience a catastrophic eruption in the next 20,000 years." ■

www.ethz.ch/campi-flegrei

ENVIRONMENTAL SCIENCES

Malaria detectable in olfactory cocktail

Researchers working under ETH Professor Consuelo De Moraes have identified odour profiles typical of people infected with malaria. Working with collaborators at the International Centre of Insect Physiology and Ecology in Nairobi, these researchers examined volatile chemicals released from the skin of Kenyan children. The composition and concentrations of these chemicals allowed them to identify characteristic patterns for both acute and asymptomatic malaria.

The researchers were able to detect the pathogen extremely reliably via the odour profiles – even when it was only present in minute quantities and was not yet observable under the microscope. Even for asymptomatic infections, the detection rate was close to 100 percent. "This high detection rate was encouraging," says De Moraes.

Next step: diagnosis in the field

The researchers hope that the biomarkers they have identified may be suitable for developing a relatively simple diagnostic tool that can be used in the field for the early detection of malaria. Methods already exist for identifying malaria pathogens at an early stage, but they are relatively expensive and require laboratory facilities. This makes their widespread use challenging, particularly in poorer countries.

"These new volatile biomarkers are an important first step. Now someone needs to develop an application that can be used cheaply and reliably in the field," says Mark Mescher, ETH Professor and co-author of the study. ■

www.ethz.ch/malaria-odour-profiles

PIONEER FELLOWS

New device for advance detection of dementia

ETH particle physicists Jannis Fischer and Max Ahnen have developed a brain scanner that is ten times less expensive and far smaller than current models. Positron emission tomography (PET) is an imaging method in nuclear medicine. It can be used to detect certain neurological conditions many years before physical symptoms can be observed. However, these machines are very large and expensive: a conventional scanner takes up around 15 square metres of floor space and costs between 1.5 and 5.5 million Swiss francs. Ahnen and Fischer's scanner, Brain PET, can be used to identify neurological disorders that result in dementia. Its footprint will be less than two square meters, making it much more portable. ■

www.ethz.ch/earlier-diagnosis-of-dementia

SINGAPORE–ETH CENTRE

Aiming for a cooler Singapore

Cooling Singapore is a research project currently running at the Singapore–ETH Centre (SEC). Working with local and international partner universities, ETH researchers are exploring ways of reducing the urban heat island (UHI) effect in the city-state.

Heat poses increasing health and energy challenges in big cities throughout the tropical belt. It's not just the tropical climate heating these cities, it's is also the continuous injection of anthropogenic heat from car exhausts, industry and fossil fuel power stations, as well as waste heat from air conditioning units. Other UHI drivers include densely packed building complexes that are not optimised for wind currents, as well as dark surfaces such as tarmac roads and building facades that store heat. The Future Cities Laboratory – an urban research group at the Singapore–ETH Centre – is hoping to break the vicious cycle of self-heating cities.

Girot's research group used a 3D laser scanner to map the large-scale urban topography of the rail corridor and its characteristics. Reflections of laser beams from objects within a distance of 300 metres produced 500,000 data points per second, which were converted into a three-dimensional model. To ensure these point clouds could be rendered in their original colours, the scanner also shot 80 images of the surroundings that were assembled into a 360° panorama.

Working with students from the Singapore University of Technology and Design (SUTD) and organised into project groups, the students fleshed out the point clouds with interventions on air conditioning to combat Singapore's urban heat island effect. Regrouping buildings and trees, for example, allows the wind to be channelled to cool the city, while increasing the amount of greenery and hence shade creates congenial spaces to spend time in. In addition, new links should be created between neighbourhoods to replace ones previously destroyed by roadbuilding. One project proposes the creation of a new park by re-routing four lanes of the main road through tunnels. ■

www.ethz.ch/cooler-singapore

Urban planning is increasingly about landscape planning, which plays a key role in creating a more comfortable climate.

In a 3-month seminar in 2018, 4 teaching assistants and 14 Bachelor's and Master's students from Zurich working under ETH Professor Christophe Girot developed a roadmap for cooling down Singapore. This first-hand experience was important for helping students gain a better understanding of the growing problem of urban heat islands. A disused railway line, now a green recreational space, was the testing ground.

Transcontinental cooperation in Singapore: a disused railway line is turned into a green corridor and natural air conditioning system for the metropolis.

FUNCTIONAL MATERIALS

Entire music album stored on DNA

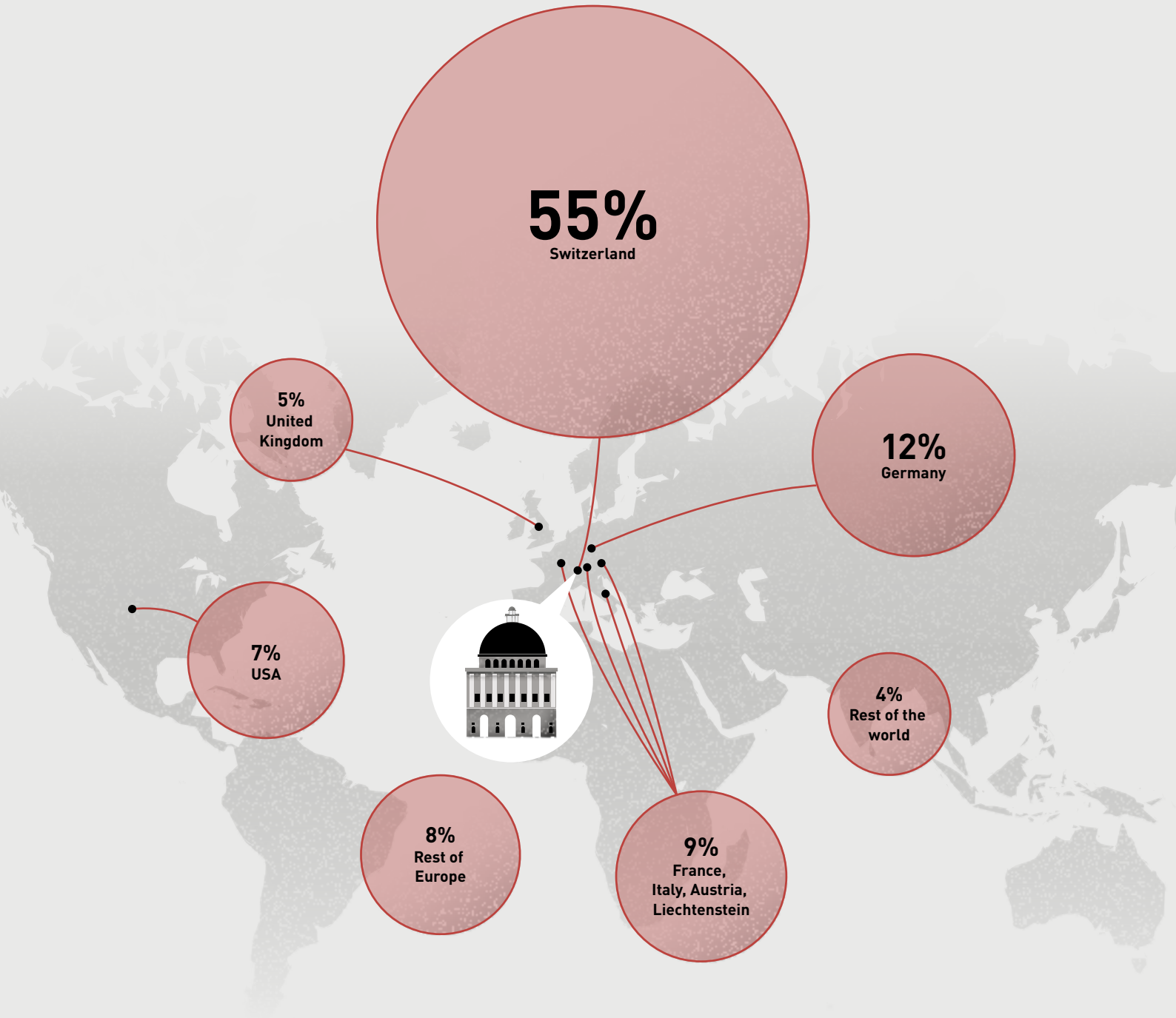
For the first time, the digital audio of an entire music album has been stored in the form of genetic information, coded on DNA molecules and encapsulated in tiny glass beads.

Robert Grass, Professor at ETH Zurich's Functional Materials Laboratory, and his colleague Reinhard Heckel, a former ETH scientist, translated the digital audio of Massive Attack's album Mezzanine into genetic code. A US company then produced 920,000 short DNA strands, which together contain all the album's information. TurboBeads, an ETH spin-off, then encapsulated these molecules in 5,000 tiny glass spheres. The album takes up 15 megabytes and is one of the biggest collections of information ever stored in DNA. ■

www.ethz.ch/music-album-on-dna

Research partnerships with the business sector

ETH Zurich maintains numerous research partnerships with private companies both in Switzerland and abroad, ranging from joint projects to exchanges between company employees and students.



Basis: 1,630 contacts 2018

Industry and society

Small and medium-sized enterprises play a vital role in the Swiss economy. ETH Zurich is now seeing the first fruits of its expanded offering for SMEs: a quarter of the enquiries to Industry Relations, the gateway for companies interested in working with the university, come from SMEs, and SMEs participate in a third of the research projects concluded via the ETH technology transfer office.

ETH spin-offs are also on course for success: two ETH spin-offs received the W.A. de Vigier Award, the most highly endowed award for young entrepreneurs in Switzerland, and with 27 ETH spin-offs, more companies were founded last year than ever before.

Major international companies continue to value collaboration with ETH Zurich. One promising initiative is the opening of a computer vision research laboratory in partnership with Microsoft. And, for the last ten years, Disney's only research unit outside the United States has continually proven its worth.

ETH scientists helped to develop the CH2018 Climate Scenarios, which show how Switzerland's climate will develop in the future and thus provide a sound basis for the Swiss government's climate change adaptation strategy.

COMPANY START-UPS

ETH spin-off machine running at full speed

ETH Zurich can look back on an exceptionally good year for spin-offs: 27 companies were founded in 2018. Financing rounds totalling over 170 million Swiss francs and the listing of Sensirion on the stock exchange bear witness to the market success of businesses launched at ETH.

In 2018, ETH Zurich achieved a new record for the number of spin-offs founded: a total of 27 founding teams took the plunge for independence. While an average of 15 ETH spin-offs were founded per year from 2000 to 2010, the current decade has seen an average of 24 per year. For Detlef Günther, Vice President for Research and Corporate Relations, the steady increase in the number of new companies over the past two decades is the best evidence that internal university support programmes pay off: "I am delighted that so many talented young people are displaying the perseverance and courage required to develop their ideas to market maturity, as this ultimately also benefits the Swiss economy and society," he says.

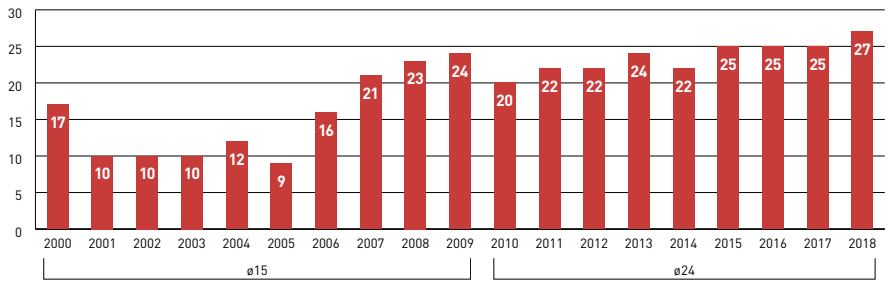
Digital technologies for medicine

The spin-offs cover a wide range of subjects and reflect the breadth of research at ETH Zurich. More companies were founded in information and communication technology than in any other field – a total of 12 in 2018. This continues a trend that emerged a few years ago. A trend is also visible in application areas: eight spin-offs from various fields are developing products for the medical sector. For example, some of the young founders are working on a new method of root canal treatment, others on a manoeuverable and inexpensive PET scanner for the early detection of Alzheimer's. In the course of the digital transformation, artificial intelligence will also become increasingly important: six of the new companies are working with machine learning methods.

Success in the marketplace

The young founders possess more than simply a good idea and faith in their own abilities, which their balance sheets make clear: over the last year, ETH spin-offs were able to attract more than 170 million Swiss francs in capital. The IPO of Sensirion in March 2018 was a good fit for the company's growth strategy. This was reflected in a year-on-year increase in revenue of 30 percent in the first 6 months. ■

www.ethz.ch/spin-offs-en



An average of 15 ETH spin-offs were founded per year from 2000 to 2009, with an average of 24 per year in the years since.

RESEARCH HUB CELEBRATES ITS ANNIVERSARY

Ten years of Disney Research in Zurich

Ten years ago, Disney Research and a quartet of scientists led by ETH Computer Science Professor Markus Gross joined forces to form a research hub. Since then, Disney's only research unit outside the USA has grown to become a highly productive laboratory with around 50 specialists, including 10 doctoral students from ETH Zurich.

Bob Sumner and Markus Gross from Disney Research Zurich at the anniversary celebration.

Supported by enormous computing power, the Disney Research team delivers dream technology for the dream factory – be it the snow in *Frozen*, which whirls amazingly realistically across the screen, or the technology that allows a deceased actor to slip back into his role from *Star Wars*. Algorithms written in Zurich have become an indispensable part of many blockbusters.

Innovations developed by Disney Research Zurich are now finding applications not just in films, but in all segments in which the entertainment group is active: media and games, toys, amusement parks and apps for the mass market. ■

The winning team (from left to right): Alessandro Bosshard, Li Tavor, Matthew van der Ploeg and Ani Vihervaara.

ARCHITECTURE BIENNALE 2018

Golden Lion for ETH team of architects

At the 16th International Architecture Biennale in Venice, the Swiss Pavilion received the Golden Lion for the first time. It was designed by four young ETH scientists.

A Swiss pavilion won the Golden Lion in Venice for the first time ever, at the 16th International Architecture Exhibition held in May 2018. The Best National Contribution came from a young team of ETH architects made up of Alessandro Bosshard, Li Tavor, Matthew van der Ploeg and Ani Vihervaara.

"The view of the interior space in which we live is more or less a blind spot in architecture. That's because architects are preoccupied primarily with plans, while occupants soon think about furnishing," explains Matthew van der Ploeg. For that reason, the team decided to make the unfurnished space the focal point for a change. They deliberately altered the usual scale of dimensions. For example, a huge kitchen can only be reached through a tiny door. "By transforming the original materials into something alien, we want to sharpen people's perception of the things that surround them," says Bosshard.

In a press release by the Pro Helvetia cultural foundation, then President of the Swiss Confederation Alain Berset praised the winning team: "This is an extraordinary success for the young team of architects and underlines the top class of Swiss architecture." ■

www.ethz.ch/biennale2018-en

ETH SPIN-OFF EXEON ANALYTICS

Software to prevent data theft

Cyberattacks pose a major risk for companies. ETH spin-off Exeon Analytics has developed software that uses big data to help companies protect themselves against data theft.

When we surf the internet, we generate vast amounts of data. Just clicking on the homepage of a Swiss news portal, for example, establishes contact with more than 30 other web servers. For the operators of large corporate networks, this becomes a problem in the fight against cyberattacks or data leaks, since detecting conspicuous operations among millions of web activities is like finding a needle in a haystack. "Cyberattackers no longer have to hide, as they blend in easily with the millions of other normal web activities," explains David Gugelmann, CEO of ETH spin-off Exeon Analytics.

David Gugelmann developed the big-data-based software called ExeonTrace together with Adrian Gämperli. It provides companies with better protection for their IT networks. The ExeonTrace algorithm uses machine learning to analyse users' actual internet activity and identifies an attacker's covert actions among millions of data points.

Gugelmann and Gämperli, who met at ETH Zurich, are currently focusing on the Swiss market. Potential customers are large companies and banks where data security is a high priority. ■

www.ethz.ch/exeon-analytics-spin-off

SPARK AWARD 2018

Award-winning artificial intestinal flora

An imbalance in intestinal flora can trigger illnesses such as asthma or diabetes. A research team led by microbiologist Tomas de Wouters has developed an artificial intestinal flora that restabilises the intestinal ecosystem. They received the 2018 Spark Award for this project.

With their ETH spin-off Pharmabiome, they plan to go on developing their invention so that it can be used in the treatment of inflammatory intestinal diseases and infections. The multidisciplinary team made up of bioinformaticians, micro- and molecular biologists, and doctors from ETH and University Hospital Zurich, hope to be able to conduct the first clinical trials as early as 2020. ETH transfer, the university's technology transfer office, honoured promising inventions with high market potential for the seventh time at this year's award ceremony on 20 March 2018. ■

www.ethz.ch/sparkaward-2018

This invention demonstrates the success of multidisciplinary collaboration.

RETHINKING INTELLIGENCE

ETH Zurich at the WEF

ETH Zurich appeared at the World Economic Forum (WEF) Annual Meeting in Davos for the second time, with an open exhibition and events on the topic of Rethinking Intelligence. Visitors to the ETH pavilion were able to play a game of rock–paper–scissors with the intelligent robot hand Dextra, or see the dog robot ANYmal in action. With "Challenge Rumantsch", ETH Zurich also presented four projects designed to promote Romansh culture and language, developed by baccalaureate school *(Gymnasium)* pupils from the canton of Graubünden and ETH students.

The public exhibition was only one part of ETH Zurich's involvement at the WEF. The ETH pavilion also hosted numerous events for invited guests. "Through our presence at the WEF, we want to enter into dialogue with top international universities and establish contacts with leading representatives from business and politics", explained Lino Guzzella, ETH President in 2018. "It's also an opportunity to bring ETH Zurich closer to the people and politics of Graubünden." ■

ETH Zurich presented its research at the WEF (right in picture: Lino Guzzella).

www.ethz.ch/eth-at-wef-2018

ETH SPIN-OFFS HONOURED

De Vigier prize for MyoSwiss and Nanoleq

Two ETH spin-offs were awarded the W.A. de Vigier Award. MyoSwiss is developing a walking aid for people with limited mobility, while Nanoleq produces cables with unrivalled longevity.

On 30 May 2018, ETH spin-offs MyoSwiss and Nanoleq along with three other prize winners received the W.A. de Vigier Award, the oldest award – and at 100,000 Swiss francs per winner, also the most valuable – for young companies in Switzerland. They were selected from over 220 entries. The jury based their decision on the product's innovative character as well as the personality of the founders, as it is they who will shape the next generation of businesses.

MyoSwiss was founded by ETH students. They are developing the Myosuit, a layer of wearable muscles that helps people with muscular weakness perform everyday activities such as walking and standing up. The solution combines robotics and functional textiles in a garment weighing less than five kilograms. Innovative algorithms combined with sensor and actuator technology control the supporting forces while the user is moving.

Nanoleq's goal is to produce extremely resilient cables for use above all in medical technology and robotics. With the FlexOne cable, the Nanoleq team has developed a radically new type of cable technology with a service life that is up to 100 times longer. The cables retain their high flexibility even under heavy loads. ■

The winners of this year's W.A. de Vigier Award.

www.ethz.ch/de-vigier-award-2018

RESEARCH PROJECT WITH GOOGLE

Controlling smartphones with gestures

On average, people spend more than one day a year unlocking their mobile phone. To speed things up, ETH Professor Otmar Hilliges and Google have developed virtual buttons and keys as part of the SOLI research project. In future it will be possible to unlock smartphones or smartwatches with quick gestures such as a finger swipe.

While Google worked on the motion sensor and the signal processing electronics in the joint research project, ETH's task was to develop the gesture recognition algorithm. According to Hilliges, the biggest challenge was that people move their fingers in different ways and the device has only a few picoseconds (10^{-12} of a second) in which to recognise them. ■

https://ait.ethz.ch/projects/2016/deep-soli/

ANNIVERSARIES FOR SENSIRION AND OPTOTUNE

Successful ETH spin-offs

ETH spin-offs Sensirion and Optotune have every reason to celebrate: 20 years after it was founded, sensor manufacturer Sensirion was listed on the stock market in March 2018. Optotune, a specialist in light-controlling optical components, celebrated its 10th anniversary and welcomed its 150th employee. So what is the secret of their success?

"We owe our success above all to our employees, many of whom studied at ETH Zurich," says Optotune founder and CEO Manuel Aschwanden. Their commitment and ideas allowed Optotune to gain a foothold in markets like computer vision, medical equipment and laser processing at an early stage.

"In addition, the ETH spin-off label helped us win the trust of several market leaders." Aschwanden believes the fact that Optotune today works with the best is one of the main reasons why the company is able to attract and retain new talent. "It is simply fun to be able to help shape the technological future," he says.

Felix Mayer and Moritz Lechner also see their employees and their corporate values as keys to their success. The two founders of Sensirion and today's Co-Chairmen of the Board say: "With the company's values and culture, we have been able to attract the best employees and offer them exciting career opportunities." To remain innovative and successful in the long term, they say, SMEs must retain the enthusiasm and decisiveness of a start-up. Going public allowed Sensirion to raise the money to expand its collaboration with other start-ups. ■

SYMPOSIUM ON THE FUTURE OF MOBILITY

Focus on e-mobility

On the occasion of the first Formula E race in Switzerland, ETH Zurich hosted the eDays Symposium on 10 June 2018. Experts from science, industry and politics debated the future of mobility.

There is no doubt: when it comes to sustainable mobility there are no simple solutions. According to ETH energy technology experts, electric motors will play an important role in the future, but will not be sufficient to achieve climate goals. It is also important to research other alternative drive systems, such as hydrogen. Christopher Onder, ETH Professor of Dynamic Systems and Control, on the other hand, stressed the importance of expanding the charging network and developing battery solutions.

For ETH Zurich, climate-friendly and energy-efficient mobility is a key topic not only in research but also in education. ETH students therefore presented their own mobility projects, including the Swissloop high-speed travel capsule and the race car built by the Academic Motorsports Club Zurich (AMZ). On 8 June, Mayor of Zurich Corine Mauch and then ETH President Lino Guzzella watched as Swiss Formula E driver Sébastien Buemi performed a demonstration run finishing in front of the ETH Main Building. ■

ETH students presented their own mobility projects during the Formula E racing weekend.

www.ethz.ch/mobility-discussion

Discussing future solutions for intelligent and sustainable mobility

COLLABORATION WITH INDUSTRY

Open doors for SMEs

Small and medium-sized enterprises play a vital role in the Swiss economy. For this reason, ETH Zurich works closely with Swiss SMEs and continues to expand its cooperation programme.

One of the primary tasks of publicly funded universities is to take the knowledge they gain from fundamental research and channel it into industry and society. Companies can only remain competitive and create jobs if they take advantage of the opportunities offered by new technologies and processes, such as additive manufacturing. Yet for a long time there was little general awareness that ETH Zurich also seeks cooperation with SMEs in this respect. For this reason, around three years ago ETH Zurich expanded its Industry Relations team to provide a gateway for companies.

We want to plug the gap between fundamental research at universities and product development in industry.

Efforts bear fruit

These efforts are now starting to bear fruit: "We're now seeing far more SMEs finding their way to ETH," says Detlef Günther, Vice President for Research and Corporate Relations. Approximately a quarter of the enquiries received by Industry Relations come from SMEs, and projects involving SMEs now make up one third of the contracts signed between companies and ETH transfer, the university's technology transfer office.

Industry Relations fielded 330 enquiries in 2018 alone. "We help them find the right people to talk to and set up meetings. But we also tell the companies how ETH works, what frameworks are available for collaborative projects, and how much those projects typically tend to cost," explains team leader Urs Zuber. In the latter stages of this process, the team evaluates possible cooperation partners at ETH, organises laboratory visits for company representatives, and runs workshops in which professors present their field of research and the company explains what they're looking for. "The best opportunities for collaboration arise from situations where you can link new knowledge from fundamental research with a concrete application," says Zuber.

Demand for mechanical engineering knowledge

The transfer of knowledge from research is particularly valued in the mechanical engineering sector. To encourage this practice, the company inspire AG was born 14 years ago out of a joint initiative of ETH Zurich and the Swiss mechanical and electrical engineering industries. "We want to plug the gap between fundamental research at universities and product development in industry," explains Martin Stöckli, COO of inspire.

Inspire has a total of 80 researchers working in 10 research groups, which are supervised by 6 ETH professors. They cover all fields of knowledge relevant to the design, development and industrial manufacturing of high-quality technical products. Typically, there are around 70 projects running at any one time, involving multiple companies and universities.

Stöckli cites the example of a collaborative project to produce micro-milling cutters from carbide. Such milling cutters are typically ground using diamond tools. However, the process wears them down, making it a very expensive method. The researchers suggested using an ultrashort pulsed laser beam instead. This essentially blasts away whatever atoms it hits, is very precise and makes production far cheaper. ■

www.ethz.ch/sme
www.ethz.ch/a-good-match

The perfect bake: pilot dough extruder for gluten-free baked goods.

MIXED REALITY & AI ZURICH LAB

Microsoft and ETH explore computer vision

Microsoft and ETH Zurich have opened a joint research laboratory for computer vision in Zurich. The US corporation and the university started building the new Mixed Reality & AI Zurich Lab in autumn 2018. Together they aim to advance both fundamental and applied research in the field of computer vision, in particular with the Microsoft HoloLens.

"Computer vision enables devices to locate and orient themselves in an environment and understand the user's activity," explains Marc Pollefeys. He is professor at the ETH Department of Computer Science and heads the 15-member team of the newly founded research laboratory. Computer vision is regarded as a core element of artificial intelligence and is a key technology in mixed reality. "Mixed reality," says Pollefeys, "comprises virtual and augmented reality, combining real and virtual elements and enabling users to interact with them."

Microsoft has been working with ETH and EPFL at the Swiss Joint Research Center since 2008. ■

SWISS CLIMATE SCENARIOS

Warmer and with less snow

How will Switzerland's climate evolve in the future? The Swiss Climate Scenarios CH2018 initiative, in which climate researchers from ETH Zurich took part, provide some answers to this question. The results published in autumn 2018 help form the basis for the Swiss government's climate change adaptation strategy.

ETH researchers from the Center for Climate Systems Modelling C2SM worked with the Federal Office of Meteorology and Climatology (MeteoSwiss) and the Oeschger Centre for Climate Change Research (OCCR) at the University of Bern to develop climate scenarios with support from ProClim. The results are officially published by the National Centre for Climate Services (NCCS). Climate scenarios and other climate services are available free of charge on the new NCCS web platform.

The researchers calculated the Swiss climate for the next few years and considered possible developments both with and without additional climate protection. They believe that, whatever we do, global warming can at best be limited. According to their calculations, Switzerland faces drier and hotter conditions in the future, with less snow and heavier and more frequent rainfall. ■

www.ethz.ch/climate-scenarios-2018

ETH researchers and representatives from industry share ideas on ETH Industry Day.

ETH INDUSTRY DAY 2018

Networking with industry

Using timber rather than concrete and steel to construct multi-storey buildings has long been considered too risky, due to the inherent fire hazard. However, a collaboration between ETH and industry has found a way of making high-rise timber buildings that are fireproof. Speaking at ETH Industry Day 2018 – its motto, "Game-changing ideas" – Professor Andrea Frangi said this heralds a renaissance for timber construction.

A total of 16 ETH researchers and ETH spin-offs presented their research projects. This year's event attracted more than 500 visitors from the business community, who once again took the opportunity to find out about current projects at ETH Zurich and make contacts.

Detlef Günther, Vice President for Research and Corporate Relations at ETH Zurich, said he was delighted at the level of interest and stressed the importance of sharing knowledge: "Industry has the practical expertise; we have the latest technologies. Together we find solutions." ■

www.ethz.ch/industryday-2018

ETH Zurich would like to usher in a digital future for the Swiss healthcare system.

DIGITAL HEALTH EVENT

Medicine from data and technology

Digitalisation has long featured in the world of medicine. At ETH Zurich's Digital Health event in early September, more than 100 guests discovered what this means for diagnosis, therapy and healthcare. It was attended by members of the public and professionals from the worlds of science, politics, healthcare and industry.

An interactive exhibition in the Dozentenfoyer faculty restaurant showed the many ways in which data and technology can be used to benefit our health. ETH Zurich researchers, spin-offs and industry partners gave an insight into what scientific research can offer the world of medicine.

"Today, around one third of all ETH researchers are working directly or indirectly on issues related to medicine," said Lino Guzzella, President of ETH Zurich until the end of 2018, during the opening ceremony. He highlighted the close relationship between the natural and computer sciences and medicine and healthcare.

There were panel discussions addressing topics such as the use of artificial intelligence and biosensors, or the responsible use of technology and data. One thing that became clear is that patients and healthy people feel differently about technological progress. While healthy people are most concerned about risks such as the misuse of data, patients mainly see opportunities. ■

www.ethz.ch/digitalhealth-event

Exploring complex interrelationships in modern medicine: a fun interactive digital platform in the ETH main hall.

MEETING OF THE DRONE INNOVATORS NETWORK

Home of drones

Switzerland's goal is to lead the world in commercial drone technology. With its drone research and spin-offs, ETH Zurich is central to these efforts. That is why the Drone Innovators Network of the World Economic Forum (WEF), founded this year, met at ETH Zurich in June 2018. ETH laid the foundations for its leading position in the field of drone technology as long ago as the 1980s, with a self-flying helicopter project in the Department of Mechanical Engineering. Since then, ETH researchers have done pioneering work to advance drone research.

For example, Raffaello D'Andrea, Professor of Dynamic Systems and Control, is currently developing drones that remain stable even after a motor failure, while the Autonomous Systems Lab focuses on drones for agriculture or search and rescue services. Meanwhile, ETH spin-offs such as Wingtra, Fotokite and Verity Studios produce drones that monitor wildlife, prevent forest and bush fires, or simply amaze audiences with precision flying displays. ■

www.ethz.ch/home-of-drones

SCIENCE AS A SUBJECT

Banknote to illustrate basic research

The 200 franc note shows Switzerland's scientific side. The main features are a particle collision and the history of the universe. ETH Professor Günther Dissertori played a key role in its design.

The Swiss National Bank (SNB) is breaking new ground in the development of its latest series of bank notes by depicting "The many facets of Switzerland" instead of well-known individuals. To introduce the subject of science on the 200 franc note, it enlisted the professional support of ETH Zurich. Together with ETH Professor Günther Dissertori, a graphic design team produced the design on behalf of the SNB.

Particle physics expert

In Professor Dissertori, the graphic designers had the support of a proven expert. For the last few years, the head of the Institute for Particle Physics and Astrophysics at ETH Zurich and his research group have been involved in the construction, commissioning, operation and data analysis of the Compact Muon Solenoid experiment at CERN. The researchers' aim is to gain new insights into the properties of the Higgs boson elementary particle. The banknote was released at the same time as new findings were published on the full characterisation of the Higgs particle.

His most confidential project yet

The scientist advised the graphics team on things like the best way to depict a particle collision or a particle detector. Dissertori also contributed to discussions on how to summarise the most important epochs or periods in the history of the universe. These were incorporated into the picture of the Big Bang on the front of the banknote. He also suggested which epochs and numbers the security strip should contain.

Overall, the development of the banknote took several years and, according to Dissertori, was the most confidential project he had ever been involved in. Looking back, he says: "It really was one of the best projects of my career, particularly in terms of outreach. To have basic research so prominently displayed on a banknote is a real testimony to the value placed on scientific research in Switzerland." ■

www.ethz.ch/interview-dissertori

Showing Switzerland from its scientific side: the new 200 franc note.

SMART FARMING FOR SWITZERLAND

Opportunities for digital agriculture

In June 2018, ETH Zurich invited stakeholders from the agricultural sector to meet with ETH scientists to share ideas and ask: "Smart farming – what does it mean for Switzerland?" Guests included then Federal Councillor Johann Schneider-Ammann. The 2018 Head of the Federal Department of Economic Affairs, Education and Research was confident that new technologies would make agriculture more sustainable. However, digitalisation doesn't only concern machines. Speaking from an entrepreneurial viewpoint, he particularly emphasised the importance of web platforms and data exchange. Many attendees from the agricultural sector hoped that digitalisation would make administrative tasks easier.

Achim Walter, ETH Professor of Crop Science, discussed the latest developments in agricultural research. Examples include a spidercam system in Eschikon that helps to monitor plant growth, and drones that could cooperate with ground robots to identify and remove weeds. ■

www.ethz.ch/digital-agriculture

Thinking – and acting – creatively

Interdisciplinary collaboration, critical and entrepreneurial thinking, independent action: ETH Zurich offers a wide range of programmes and projects designed to help students develop these skills. A visual tour.

ETH Week – interdisciplinary focus
ETH Week brings together students from ETH Zurich's various academic departments, putting them into small groups to work on a problem that they define independently. At the most recent ETH Week, participants studied all aspects of how energy is produced, distributed and stored. At the conclusion of their six days together, the students presented their creative concepts for solving relevant problems. The programme also offers an extensive range of company visits and expert talks, along with evening recreational activities.

www.ethz.ch/ethweek

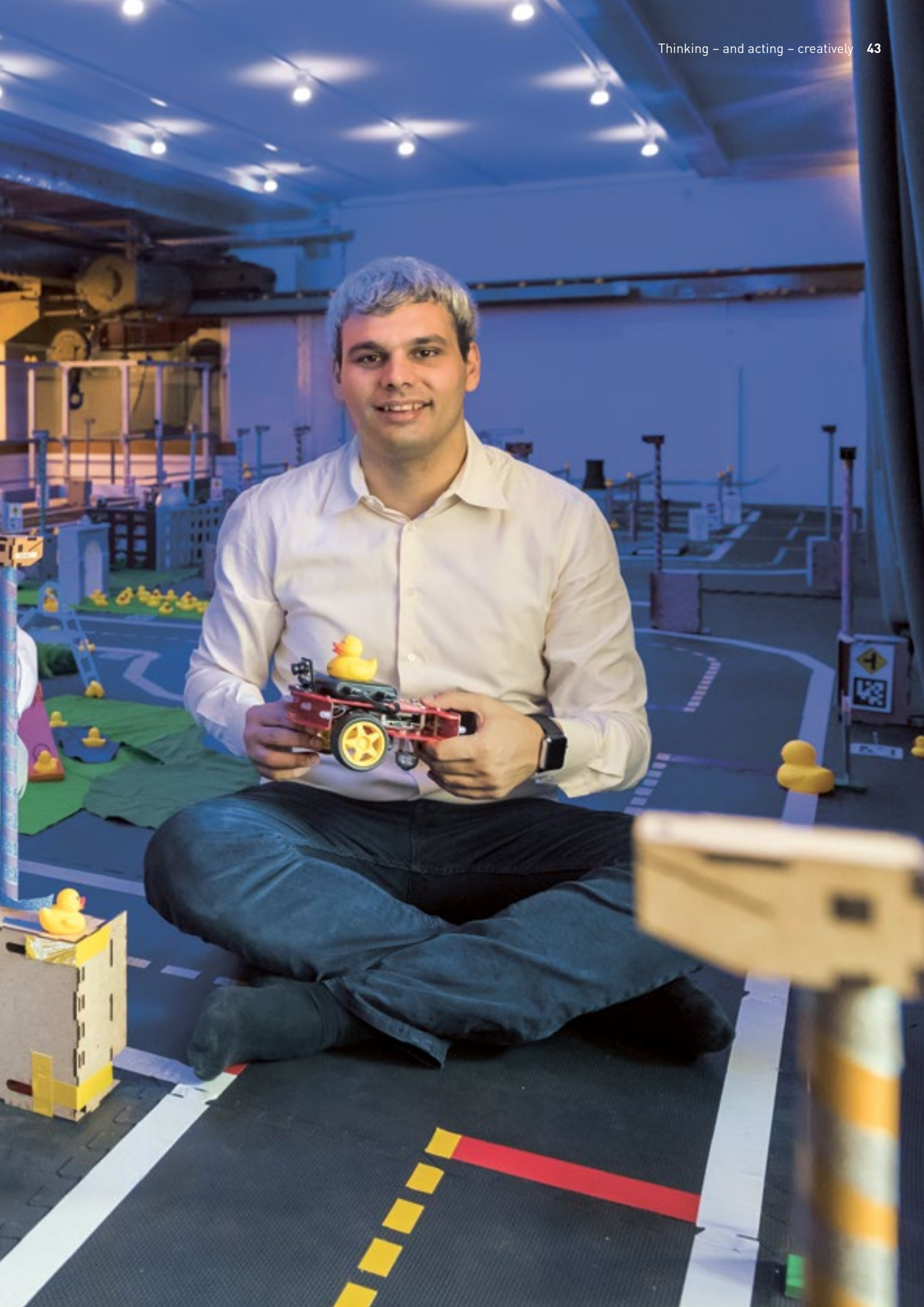
Student Project House (SPH) – independence
Project work and independent thinking are becoming an increasingly important part of an ETH Zurich education, and it's facilities like the Student Project House that are giving students the space and resources they need to take on this challenge. Here in the Maker-space they can develop their ideas and turn them into concrete projects. And for anyone looking for an expert in another field, the SPH hosts events where they can find just the right partner, whether a fellow student looking to join a team or an experienced coach ready to share their knowledge.

www.ethz.ch/student-project-house-en

Duckietown – open source

It might look like a game, but it's certainly not child's play to keep a fleet of rubber-duck taxis on the road as they stop at intersections, yield the right of way, and hit the brakes when traffic comes to a halt. Andrea Censis and Jacopo Tanis run a Duckietown course that puts Master's students to work on the same problems facing autonomous vehicle developers around the world. They work on the same code with students from the Université de Montréal and the Toyota Technological Institute at Chicago. As part of this open source project, students document their solutions so that future students – and researchers from around the world – can build on them in their own work.

www.ethz.ch/duckietown-news



InCube (ETH Entrepreneur Club) – design thinking
Five students spent four days and four nights inside a giant glass cube on the Polyterrasse, thinking about how digital technologies can help to facilitate lifelong learning. They went head-to-head with five other student teams, each working from their own location to respond to their own particular challenges, and each racing to develop a prototype under very strict deadlines. The ETH Entrepreneur Club, an ETH Zurich student organisation, staged this unique competition for the second time in 2018.

https://incube2018.com

Pioneer Fellows – entrepreneurship

He grew up in a clay house in West Africa, and today Gnanli Landrou heads Oxara, an ETH spin-off working to develop cement-free concrete based on clayey excavated soil. A Pioneer Fellowship from ETH Zurich is helping Landrou to develop his innovative product – which he hopes will enable affordable, sustainable housing in Africa and around the world – and establish his company. He has received initial funding in the amount of 150,000 Swiss francs and has access to the university's office spaces and lab facilities as he works to turn his business ideas into a reality.

www.ethz.ch/oxara-portrait
www.ethz.ch/pioneer-fellowships


Zyklos
made by Pemat

Outstanding successes with ERC Grants

ETH researchers have been successfully applying for prestigious grants from the European Research Council (ERC) since 2007; these grants honour the work of researchers while also providing them with an independent source of financing. ERC Grants are a key component of the European Framework Programmes for Research and Innovation FP7 (2007–2013) and Horizon 2020 (2014–2020), in which Switzerland once again became a full participant in January 2017.

77 Advanced Grants
23 Consolidator Grants
2 SNSF Consolidator Grants*

58% of applications come from experienced scientists

56 Starting Grants
3 SNSF Starting Grants*
14 Proof of Concept Grants
2 Synergy Grants

*These grants were financed by the Swiss National Science Foundation (SNSF) and the State Secretariat for Education, Research and Innovation (SERI) during the period when Swiss researchers were excluded from European research framework programmes due to the approval of the initiative on mass immigration (9 February to 5 September 2014)

177 ERC Grants since 2007

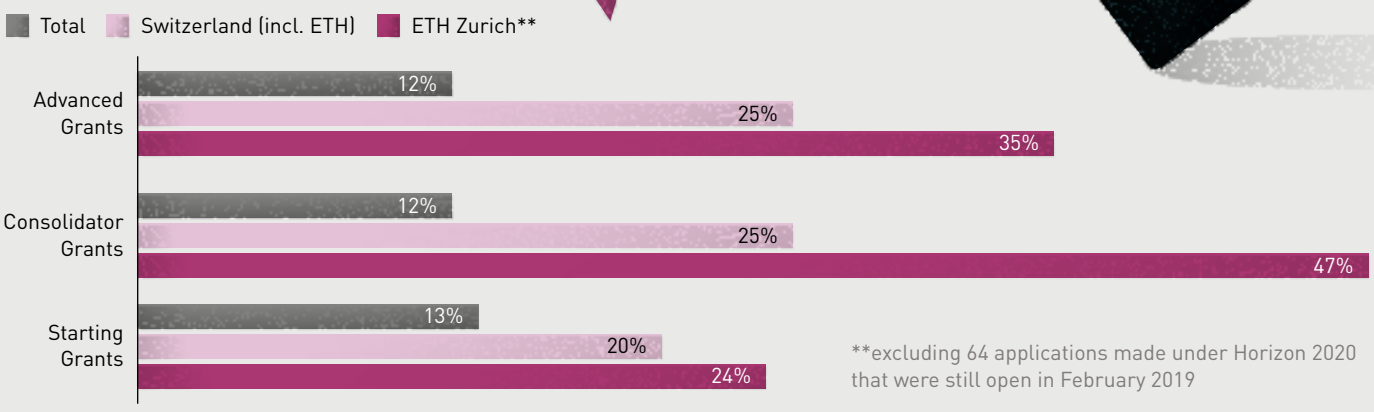
CHF 375 million
funding received

26 ERC Grants 2018

10 Advanced Grants
10 Consolidator Grants
5 Starting Grants
1 Synergy Grant

CHF 57.2 million
funding received

Success rate for ERC applications



**excluding 64 applications made under Horizon 2020 that were still open in February 2019

Honours and awards

In 2018, many ETH scientists again won major prizes and awards. Such awards not only enhance the university's outstanding international reputation, but also confirm ETH's continuing commitment to providing its researchers with the facilities and work environment they need to produce their very best academic performance.

Alessio Figalli received a particularly special award: his outstanding contribution to mathematical research won him the Fields Medal, an award that is to mathematics what the Nobel Prize is to natural sciences. Ursula Keller received the European Inventor Award in the lifetime achievement category. Lars-Erik Cederman was awarded the Marcel Benoist Swiss Science Prize and Antonio Lanzavecchia received the Louis Jeantet Prize for Medicine – to name just a few prize winners. In addition, the university received a total of 26 prestigious grants awarded by the European Research Council (ERC). These grants not only support projects which the university could not finance by itself, but are also an important benchmark for the quality of our research. The funding received by ETH scientists breaks down into one ERC Synergy Grant, ten Advanced Grants, ten Consolidator Grants and five Starting Grants.

His original and elegant mathematical proofs help to solve fundamental problems: Alessio Figalli, winner of the 2018 Fields Medal.

FIELDS MEDAL

Alessio Figalli wins the "Nobel Prize of mathematics"

Alessio Figalli, Professor of Mathematics at ETH Zurich, received the Fields Medal for his outstanding contribution to mathematical research. The medal is to mathematics what the Nobel Prize is to natural sciences.

This is a great honour for Alessio Figalli, a mathematics professor at ETH Zurich since 2016. The International Mathematical Union (IMU) awarded the Fields Medal to the Italian citizen at the International Congress of Mathematicians 2018 (ICM 2018) in Rio de Janeiro. The Fields Medal is the most prestigious award in the field of mathematics.

Optimal transport – even in nature

The IMU conferred the award on Figalli for his contributions to the theory of optimal transport and its applications in partial differential equations, metric geometry, and probability. Amongst several contributions, he solved a problem dating back over 20 years involving the Monge-Ampère equation, a famous partial differential equation that was introduced in the 19th century and is now applied in many different areas, including urban planning, imaging and meteorology. The rationale behind the equation is that total transport costs need to be kept as low as possible.

This also applies to many change processes in nature: for example, soap bubbles and crystals attain their attractive geometric shape by minimising surface energy. Figalli has mathematically proven that the abrupt changes in cloud formations in major weather fronts can be broken down into optimal transport equations. When the clouds change shape, the particles move in an optimal, energy-efficient way from their initial state to another.

Mathematics is creative

At just 34 years of age, the mathematician already has a distinguished CV. He completed his doctorate in 2007 after just one year. He was appointed Associate Professor at the University of Texas at Austin at the age of 25, and promoted to Full Professor at the age of 27. Then he joined ETH Zurich as Full Professor when he was 32. He has received many awards and distinctions, with the Fields Medal representing the high point of his career to date.

Figalli is convinced that creativity is the key to devising new tools and techniques to solve mathematical questions. "It's great to be the first to prove something that has occupied many mathematicians for years," says Figalli. "I'd like to show talented young people how creative and exciting mathematics really is. The vibrant and dynamic setting I have encountered here at ETH Zurich is the perfect place to do that." ■

www.ethz.ch/fields-medal-figalli-2018

Antonio Lanzavecchia was honoured for his findings in the field of human immune response to infections.

LOUIS JEANTET PRIZE FOR MEDICINE

Outstanding immunologist

The Louis Jeantet Prize for Medicine is awarded every year to outstanding researchers working in Europe in the field of biomedicine. Antonio Lanzavecchia, Professor Emeritus in ETH's Department of Biology and Director of the Institute for Research in Biomedicine at the Università della Svizzera italiana, was one of two prize winners. He was honoured for his research in the field of human response to infections and their importance in the development of vaccines and antibody-based therapies.

Lanzavecchia has developed methods to isolate potent and broadly neutralising antibodies against a variety of common and emerging pathogens responsible for life-threatening diseases (such as Ebola or the Zika virus). This technology led to the discovery of a new type of antibody specifically targeted against malaria parasites. This understanding of the mechanism of antibody diversification has had a decisive influence on our understanding of the body's interaction with pathogens. ■

EUROPEAN INVENTOR AWARD

Lifetime achievement award

Ursula Keller has been awarded the European Inventor Award for lifetime achievement.

ETH Professor Ursula Keller received the European Inventor Award in the lifetime achievement category for her research into ultrafast lasers.

Keller's discovery of how to transform continuous laser light from diode-pumped solid-state lasers into ultrafast laser pulses allowed procedures in science, industry and medicine to be carried out with unprecedented precision. Keller developed her SESAM (semiconductor saturable absorber mirror) technology at ETH Zurich from 1993 onwards. She succeeded in producing ever shorter laser pulses, until only one or two light oscillations were contained in one laser pulse. This advance allowed Keller to invent the most accurate clocks in the world: the attoclock and the optical clock.

Almost all industrial short pulse laser systems are now fitted with the SESAM technology. For example, it is used to remove extremely thin slices of material only a few nanometres thick, or to perform delicate eye operations without heating the surrounding material. ■

www.ethz.ch/inventor-award-ursula-keller

Lars-Erik Cederman received the Marcel Benoist Prize for his international conflict research.

MARCEL BENOIST PRIZE

The importance of balance

ETH Zurich peace and conflict researcher Lars-Erik Cederman has won Switzerland's biggest science award for 2018, the Marcel Benoist Prize.

Would a divided Syria be more peaceful than an intact country? Would the secession of Catalonia – a move to independence from Spain – tend to worsen or improve conflict with Madrid? These are the sort of questions that Lars-Erik Cederman is studying from a globally comparative perspective. Cederman is a political scientist and works with modern data and computer-aided methods.

He was the first social scientist to win the Swiss Marcel Benoist Science Prize since the economist Ernst Fehr in 2008. He receives the award for his research into the causes of and approaches to solutions for conflicts between ethnic minorities and central state governments. One of the phenomena he has demonstrated is that political and economic inequalities between a centralised state and minorities increase the potential for conflict, while a balanced distribution of power and wealth and the fulfilment of basic needs can stabilise a country. ■

www.ethz.ch/cederman-portrait

ERC Grants and special awards to ETH members

ERC SYNERGY GRANT

Professor Nicola Spaldin, D-MATL, and **Professor Gabriel Aeppli,** D-PHYS, EPFL, PSI, and two researchers from EPFL and Stockholm University are seeking to uncover quantum properties of materials undetectable with past methods.

www.ethz.ch/synergy-grant-news

ERC ADVANCED GRANTS

Professor Peter L. Bühlmann, D-MATH, will develop efficient and robust prediction methods to explore questions and scenarios in biology and economics.

Professor Lars-Erik Cederman, D-GESS, is proposing a new theory of nationalist state transformation.

Professor Martin Fussenegger, D-BSSE, is working on the principles of synthetic gene networks.

Professor Ursula Keller, D-PHYS, aims to develop a new type of dual-comb semiconductor laser for use in mid-infrared spectroscopy.

Professor Ruben Kretzschmar, D-USYS, wants to develop new approaches that will make it possible for the first time to investigate iron mineral transformations in situ in soils and sediments.

Professor John Lygeros, D-ITET, is developing new control methods that can be used to optimise large-scale, data-intensive applications.

Professor Marco Mazzotti, D-MAVT, is trying to fill the gaps in scientific understanding of secondary nucleation at the microscale.

Professor Rahul Pandharipande, D-MATH, is looking to gain further insight into moduli spaces, and to help solve integrals relevant to string theory.

Professor Ruth Signorell, D-CHAB, uses photoelectron spectroscopy to study elementary transport processes of slow electrons in liquids and at the interface between liquids and gases, solids and other liquids.

Professor Heini Wernli, D-USYS, wishes to obtain a comprehensive picture of how meteorologically extreme seasons are shaped in current and future climates.

www.ethz.ch/advanced-grants-news

ERC CONSOLIDATOR GRANTS

Dr Paolo Crivelli, D-PHYS, aims to explore the nature of muons and muoniums with unprecedented accuracy.

Professor Christian Degen, D-PHYS, would like to develop a new technique for observing and imaging currents at the nanoscale.

Professor Jonathan Home, D-PHYS, will explore a new method for scaling ion trap quantum computing and simulation.

Professor Andreas Krause, D-INFK, seeks to develop new "reinforcement learning" methods with a previously unattained level of reliability.

Professor Maksym Kovalenko, D-CHAB, uses chemical engineering approaches to broadly tune the optical properties of metal halides.

Professor Christoph Müller, D-MAVT, wants to improve the ability of alkaline-earth metal oxides to capture a large quantity of CO_2 at a high rate and regenerate it with high cyclical stability.

Professor Nicolas Noiray, D-MAVT, plans to develop novel passive and active control technologies to prevent harmful thermoacoustic instabilities in future gas turbine combustors.

Professor David Steurer, D-INFK**,** aims to develop an algorithmic method that guarantees an efficient solution whenever possible and thus achieves optimal efficiency.

Professor Mehmet Fatih Yanik, D-ITET, wants to improve understanding of brain activity patterns and correct them using minimally invasive brain–machine interfaces and precise drug delivery technologies.

Professor Rico Zenklusen, D-MATH, is developing automated methods using novel algorithmic approaches which help to find the best solutions to complex problems within a reasonable period of time.

www.ethz.ch/consolidator-grants-news

ERC STARTING GRANTS

Professor Dominik Hangartner, D-GESS, evaluates key parameters of the asylum process by combining advances in statistical methodology and large-scale registry data.

Professor Lavinia Heisenberg, D-PHYS, studies the properties of field theories of the space–time continuum, their cosmological consequences and the signatures that can be used to determine the validity of such theories.

Professor Pablo Rivera Fuentes, D-CHAB, develops methods for observing living cells in single-molecule resolution.

Professor Berend Snijder, D-BIOL, wants to understand why individual cancer patients can respond so differently to their treatment ("cancer individuality") and find ways to develop personalised cancer therapies.

Professor Michalis Vassiliou, D-BAUG, is studying the seismic behaviour of brickwork buildings.

www.ethz.ch/starting-grants-news

DR J.E. BRANDENBERGER FOUNDATION AWARD

Professor Reto Knutti, D-USYS, was awarded the 2018 prize of the Dr J.E. Brandenberger Foundation for his achievements in the field of climate change research and the communication of his results to the public.

www.ethz.ch/brandenberger-award

DORON PRIZE

Professor Jürg Leuthold, D-ITET, received the prize for his key role in the further development of the internet infrastructure.

www.ethz.ch/leuthold-receives-doron-prize

LATSIS PRIZE (OF ETH ZURICH)

Professor Sereina Riniker, D-CHAB, was honoured for her work on molecular dynamic simulations, which improve the search for new drugs.

www.ethz.ch/latsis-prize-2018

LOPEZ-LORETA PRIZE

Dr Sebastian Krinner, D-PHYS, was awarded the prize for his project to build logical quantum bits for quantum computers based on superconducting circuits, in order to reduce the error rates of quantum states.

www.ethz.ch/lopez-loreta-prize-2018

OTTO NAEGELI PRIZE

Professor Nenad Ban, D-BIOL, was honoured for his work in improving understanding of the atomic structure of protein synthesis machinery in eukaryotic cells and mitochondria.

www.ethz.ch/otto-naegeli-prize-2018

RÖSSLER PREIS (OF ETH ZURICH)

Professor Philippe Block, D-ARCH, received the prize for his research in building technology. He is looking for new structural forms and construction systems that allow materials to be used more efficiently.

www.ethz.ch/max-roessler-prize-2018

More honours and awards given to ETH members can be found at www.ethz.ch/honours.

Honorary doctorates and honorary councillors

Honorary doctors Professor Stefan W. Hell, Professor Lia Addadi and Professor Naomi Oreskes, as well as honorary councillor Professor Hans Hengartner (from left to right).

Honorary doctorates

By awarding honorary doctorates, ETH Zurich honours individuals for their outstanding scientific work and recognises their important contribution to science, education and practical applications or to the synthesis of research and practical work.

Professor Stefan W. Hell
In recognition of his theoretical and experimental concepts on breaking the diffraction resolution limit in light microscopy and the development of super-resolution fluorescence microscopy.

Professor Lia Addadi
In recognition of her groundbreaking work on biomineralisation that has significantly shaped our understanding of the formation of organic crystals and mineral complexes in living organisms, and opened up extensive applications in medicine and materials science.

Professor Naomi Oreskes
In recognition of her original historical and sociological research, considered not only exceptionally thorough but incredibly well informed from a natural science perspective, on the history of earth sciences and her significant contributions to the discussion on anthropogenic climate change.

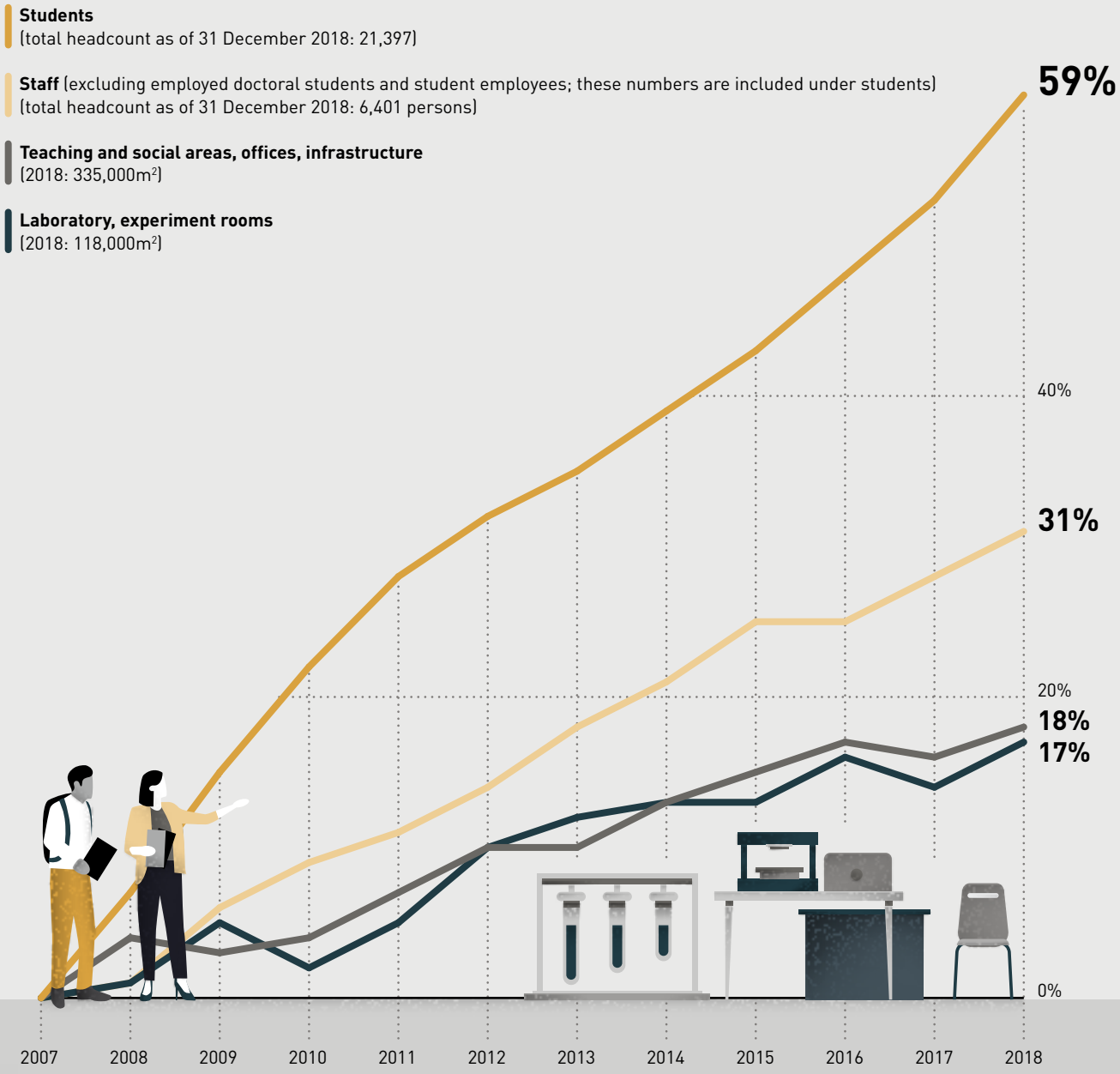
Honorary councillors

The title of honorary councillor is awarded to individuals who have played an instrumental role in promoting scientific work or fields that are important to ETH Zurich, or have supported the university as a whole.

Professor Hans Hengartner
In recognition of his exceptional commitment to promoting teaching and research at ETH Zurich, especially for his role in building bridges between universities, research and society, as well as his tireless and successful efforts to implement visionary ideas.

Trends in ETH staff and infrastructure

Since 2007, the number of ETH students and employees has been rising faster than the available room space. The university has mainly cushioned the growing demand for space by using available space more efficiently, as well as constructing new buildings and leasing extra room. Future development will be concentrated on the Hönggerberg campus, where the focus will be on the consolidation rather than the expansion of the existing infrastructure.



Infrastructure development (main usable area) excl. rooms being remodelled and spaces rented to third parties

Human resources and infrastructure

The number of employees at ETH Zurich continued to grow in 2018, and the university has introduced a series of measures to constantly improve working conditions for staff. One example is the annual ALEA Award, which emphasises the importance of leadership skills for the university's success. The award honours leaders who encourage modern and innovative working conditions and who help staff strike a balance between their work, family life and other commitments. Every year between 40 and 50 people are nominated, most of them professors. In 2018, Professor Laura Nyström received the ALEA Award for her exemplary leadership.

As staff numbers grow, ETH Zurich continues to expand its infrastructure. In 2018, new development was concentrated in Basel and on the Hönggerberg campus. The foundation stone for the new building in Basel was laid in September. As of 2022, all research groups at the Department of Biosystems Science and Engineering will be brought together under one roof on the Schällemätteli campus, close to important partners. The Hönggerberg campus is to be consolidated according to the Master Plan 2040 that ETH has drawn up in cooperation with the city and canton of Zurich. The focus will be on consolidation before expansion, and creating an attractive space with a city neighbourhood feel.

Staff by function

ETH Zurich (consolidated) Full-time equivalents (FTEs), at the end of 2018 (reporting date) or annual average	FTEs annual average						FTEs on reporting date at y/e
					Increase		
	2017 Total	2018 Total	Women	International staff	Absolute	in %	2018 Total
Total staff [1]	**9,281.1**	**9,527.9**	**32.9%**	**56.4%**	**246.8**	**2.7%**	**9,789.0**
of which permanent members of staff	2,955.1	3,032.9	30.0%	30.0%	77.8	2.6%	3,048.6
Professors [2]	**490.8**	**495.7**	**15.0%**	**67.1%**	**4.9**	**1.0%**	**492.2**
Full professors	401.1	404.4	13.4%	64.6%	3.3	0.8%	402.3
Assistant professors	89.7	91.4	21.9%	78.5%	1.6	1.8%	89.9
Scientific staff	**5,964.1**	**6,093.5**	**30.3%**	**71.2%**	**129.4**	**2.2%**	**6,290.1**
Permanent scientific staff	257.5	259.0	15.1%	44.2%	1.5	0.6%	261.2
Temporary scientific staff	5,321.0	5,416.1	30.6%	75.3%	95.1	1.8%	5,523.9
Senior assistants, scientific staff (temporary)	616.0	617.1	25.6%	72.5%	1.1	0.2%	639.2
Postdoctoral students, scientific research assistants II	1,107.0	1,108.3	30.9%	89.8%	1.3	0.1%	1,122.3
Scientific research assistants I	3,598.0	3,690.7	31.3%	71.4%	92.7	2.6%	3,762.4
Teaching/research assistants	385.6	418.4	35.7%	35.0%	32.7	8.5%	505.0
Technical and administrative staff	**2,658.4**	**2,766.9**	**42.4%**	**24.8%**	**108.5**	**4.1%**	**2,833.7**
of which permanent members of staff	2,298.4	2,371.9	42.1%	22.5%	73.4	3.2%	2,387.2
Technical and IT staff	1,427.5	1,484.5	19.3%	30.0%	57.0	4.0%	1,520.1
Administrative staff	1,230.9	1,282.4	69.0%	18.9%	51.5	4.2%	1,313.6
Apprentices	**167.8**	**171.8**	**28.4%**	**6.2%**	**3.9**	**2.3%**	**173.0**

[1] Including 130.2 FTEs at ETH Singapore SEC Ltd. (SEC) on average in 2018, on the reporting date 135.8 FTEs; all are allocated fully to the Scientific research assistants I.
[2] Headcount 2018: 528 (incl. professors with appointments at other institutions).

www.ethz.ch/staff-stats

STAFF PARTY

Community atmosphere at the togETHer18 staff party on Hönggerberg campus

Every two years the ETH community celebrates at the togETHer staff party.

The setting of the togETHer18 staff party was designed as an outsized home for the ETH community, with a mock living room, hobby space and kids' room. Around 3,500 staff and their guests braved the rain and unusually cold weather on the last day of August to soak up the communal atmosphere of the shared space on the Hönggerberg campus. Food, drink and entertainment were laid on at the party, which went on till midnight. The programme included the ceremony for the ALEA Award for exemplary leadership (see page 58), a set from Paul das Pausenbrot – a cover band playing the best party songs from the last 50 years – and the Zurich DJ Rolf Imhof. Anyone who likes to sing also had a chance to make their voice heard in the karaoke bar.

www.ethz.ch/together-en

Staff by area

Total staff Full-time equivalents (FTEs), at the end of 2018 (reporting date) or annual average [1]	FTEs annual average						FTEs on reporting date at y/e
	2017 Total	2018 Total	Women	International staff	Increase Absolute	Increase in %	2018 Total
ETH Zurich (consolidated)	**9,281.1**	**9,527.9**	**32.9%**	**56.4%**	**246.8**	**2.7%**	**9,789.0**
Departmental total	**7,575.4**	**7,699.4**	**31.9%**	**62.8%**	**124.0**	**1.6%**	**7,901.3**
Architecture and Civil Engineering	971.9	980.4	34.1%	56.6%	8.5	0.9%	1,002.4
Architecture	406.0	409.8	40.2%	55.3%	3.8	0.9%	404.6
Civil, Environmental and Geomatic Engineering	565.9	570.6	29.7%	57.6%	4.7	0.8%	597.8
Engineering Sciences	2,245.5	2,282.7	21.6%	67.6%	37.2	1.7%	2,343.0
Mechanical and Process Engineering	731.5	711.3	18.6%	62.1%	– 20.2	– 2.8%	719.6
Information Technology and Electrical Engineering	579.9	584.1	19.1%	67.4%	4.2	0.7%	587.7
Computer Science	404.8	446.0	18.8%	68.9%	41.2	10.2%	483.9
Materials	230.7	235.4	26.4%	65.9%	4.7	2.0%	235.6
Biosystems Science and Engineering	298.6	305.9	33.9%	80.1%	7.3	2.5%	316.2
Natural Sciences and Mathematics	2,325.8	2,323.2	31.3%	62.6%	– 2.6	– 0.1%	2,378.7
Mathematics	283.3	287.8	23.8%	62.7%	4.5	1.6%	315.3
Physics	627.8	629.2	18.9%	57.3%	1.3	0.2%	630.7
Chemistry and Applied Biosciences	800.9	802.5	31.9%	63.4%	1.6	0.2%	823.9
Biology	613.8	603.7	47.1%	67.0%	– 10.1	– 1.6%	608.9
System-oriented Natural Sciences	1,425.3	1,486.9	44.2%	59.8%	61.6	4.3%	1,546.3
Earth Sciences	335.9	323.9	33.4%	68.3%	– 12.0	– 3.6%	337.2
Environmental Systems Science	624.0	646.4	44.7%	57.3%	22.4	3.6%	664.4
Health Sciences and Technology	465.5	516.6	50.4%	57.5%	51.1	11.0%	544.6
Management and Social Sciences	606.8	626.2	38.8%	62.6%	19.4	3.2%	630.9
Management, Technology, and Economics	325.9	338.2	39.5%	66.2%	12.4	3.8%	346.9
Humanities, Social and Political Sciences	281.0	288.0	38.0%	58.3%	7.0	2.5%	284.1
Teaching and research facilities outside the academic departments, others [2]	**436.6**	**509.4**	**33.6%**	**61.5%**	**72.7**	**16.7%**	**535.9**
Executive Board, staff units and administrative departments	**1,269.1**	**1,319.1**	**38.8%**	**17.1%**	**50.0**	**3.9%**	**1,351.8**
Executive Board and staff units	116.2	132.3	61.1%	23.0%	16.1	13.9%	137.1
Administrative departments	1,152.9	1,186.8	36.3%	16.4%	33.9	2.9%	1,214.7
Corporate Communications	27.5	27.6	51.0%	22.1%	0.1	0.3%	26.4
Academic Services	58.3	60.5	63.6%	13.8%	2.3	3.9%	61.8
Educational Development and Technology	27.4	31.9	40.8%	24.9%	4.4	16.2%	33.8
Student Services	15.9	15.6	79.5%	3.8%	– 0.3	– 2.0%	16.2
Controlling	19.9	20.9	50.3%	4.8%	1.0	5.2%	22.0
Financial Services	17.4	18.0	30.2%	13.9%	0.5	3.1%	18.6
Accounting	39.6	41.4	39.9%	16.3%	1.8	4.5%	44.4
Facility Management	191.1	189.4	18.8%	20.5%	– 1.7	– 0.9%	192.6
ETH Library	219.6	218.1	59.5%	15.5%	– 1.5	– 0.7%	222.9
Real Estate	68.8	72.8	28.5%	15.6%	4.0	5.8%	74.5
IT Services	266.1	278.7	11.7%	18.5%	12.5	4.7%	283.2
Human Resources	65.7	71.7	68.4%	10.8%	6.1	9.2%	74.2
Services	94.4	98.1	41.9%	11.2%	3.7	3.9%	102.3
Safety, Security, Health and Environment	40.0	41.2	27.9%	17.3%	1.2	3.0%	41.3

[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 31 December 2018. Since 2017, both the headcount 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 the 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, B&R Nanotechnology Center, ScopeM, ETH Phenomics Center, Swiss Seismological Service (SED), CSCS, AgroVet-Strickhof, Swiss Data Science Centre (SDSC) and other central projects. The headcount of the fully consolidated unit ETH Singapore SEC Ltd. is also included (135.8 FTEs as at 31 December 2018 and 130.2 FTEs on average in 2018).

Laura Nyström, winner of the ALEA Award.

ALEA AWARD

Laura Nyström honoured

At the togETHer18 staff party, Professor Laura Nyström was presented with the ALEA Award as ETH Zurich's most exemplary leader. The professor, who works at the Institute of Food, Nutrition and Health, is one of 46 managers nominated as best leader by their employees this year. "A friendly, respectful atmosphere characterised by responsibility and trust was one of the aspects that her research group particularly appreciates," said Linda Wehner, representative of the scientific staff association AVETH, before presenting the award to Nyström. Her staff also value her extraordinary support in promoting a good work/life balance and helping employees with their career progression. The award aims to emphasise the huge importance of leadership skills for the success of ETH and promote a suitable leadership culture. The prize is awarded annually by AVETH with support from the Equal! Office of Equal Opportunities and the HR department. ■

www.ethz.ch/alea-award

HUMAN RESOURCES

New career profile for senior scientists

ETH Zurich employs around 300 senior scientists on permanent contracts. "Senior scientists are crucial for the quality of our research and teaching, and always will be," says Lukas Vonesch, Head of Human Resources. Past experience showed, however, that some clarification was required concerning the job profile, expectations and professional development of senior scientists. The academic departments and university groups therefore embarked upon a consultation process on various measures for strengthening this group of employees, with a view to implementing a transparent career concept. Four role profiles were introduced at the beginning of 2019, each with a different focus: research, teaching, technology, and research coordination. Compulsory teaching and research components are also defined for each of the four role profiles. "ETH wants to support its senior scientists in their continuing professional development," Vonesch comments. Every two years a career consultation will be arranged to discuss the employee's long-term development opportunities. ■

www.ethz.ch/working

BIOSYSTEMS SCIENCE AND ENGINEERING

A new home for D-BSSE in Basel

In September 2018, ETH laid the foundation stone for its new department building on the Schällemätteli campus in Basel. As of 2022, all the research groups at the Department of Biosystems Science and Engineering will be united under one roof.

Researchers in the Department of Biosystems Science and Engineering (D-BSSE) in Basel develop mathematical models to gain a better understanding of epidemics. They also search through large data sets for correlations between genetic characteristics and the occurrence of complex diseases, and test pharmaceutical agents in cell tissues on electronic chips. Their goal is to advance synthetic biology and personalised and data science-based medicine through interdisciplinary cooperation. D-BSSE engineers, experimental biologists and bioinformatics specialists will all be accommodated in the new building on the Schällemätteli campus from 2022 onwards. ETH Zurich is investing some 200 million Swiss francs in the new building.

"Medicine and life science are among ETH Zurich's strategic priorities," said then ETH President Lino Guzzella at the laying of the foundation stone in September. "Our department in Basel gives us access to a research network that is a world pioneer in this area." The new building in the immediate vicinity of the University of Basel, the University Hospital Basel and the University Children's Hospital Basel will give D-BSSE a new home while promoting interaction with industry and medical research. "We greatly value the current collaboration with our local partners and hope that the physical proximity will mean we can benefit even more from each other's expertise," commented Timm Schroeder, Head of D-BSSE.

On the new campus, ETH Zurich and the University of Basel will also cooperate more closely at the infrastructure level, resulting in further synergies. The scientific facilities housed in the new ETH building will be available to University of Basel members, while ETH researchers will in turn benefit from sharing the university's laboratory animal units. The ETH building will be supplied with heating, cooling and hot water from nearby University of Basel buildings. The Genomics Facility Basel, which is already co-managed with the University of Basel, will continue as a joint venture at the new site; here researchers will have state-of-the-art equipment for genome sequencing and data analysis at their disposal. ■

www.ethz.ch/laying-of-the-foundation-basel

IT SERVICES

New IT platform for confidential data

Researchers at ETH Zurich now have access to a new infrastructure for big data analytics. Leonhard Open is designed for open (public) research data, while Leonhard Med is intended for particularly sensitive data where confidentiality is paramount.

The new IT platform Leonhard comprises two computing clusters. Both are optimised for analysing large quantities of data, and also for machine learning. The Scientific IT Services section of ITS headed by Bernd Rinn started operating Leonhard in January 2018.

Leonhard Open is available to ETH members who work with open, non-sensitive research data, while Leonhard Med is a secure system intended for confidential data used in areas such as personalised medicine. Two initiatives – the Swiss Personalized Health Network and Personalized Health and Related Technologies – will accelerate the growth of ETH's biomedical research community. "The challenge wasn't just to develop a system that provides top performance while also being extremely secure. It also had to be flexible and easy to use," Rinn says.

The two computing clusters have separate logical storage systems, log-in nodes and network connections. This separation, combined with integrated encryption, assures a high level of protection for confidential data.

Leonhard is funded by ETH Zurich and users themselves. The system is reserved exclusively for use by shareholders. This differentiates the platform from the high-performance cluster Euler, which anyone with ETH access can use. "Euler and Leonhard complement each other," says Rinn. While Euler targets a broader research community, Leonhard is optimised specifically for data-intensive work with a high security level. ■

www.ethz.ch/it-in-research
https://scicomp.ethz.ch/wiki/Leonhard

ETH LIBRARY

New platform for libraries

The Swiss Library Service Platform (SLSP), a non-commercial corporation in which ETH Zurich is an investor, will replace the existing associations of Swiss university libraries. By the end of 2020, all catalogue data and the basic services of the science libraries will be integrated into the new platform. The SLSP will take over technical operation with a common library system, and also offer services that the current university library associations provide locally and to an extent redundantly. This includes the NEBIS network, which the ETH Library has been operating successfully for over 30 years for more than 140 member libraries. "It's time to think on a grander scale," says Andreas Kirstein from the ETH Library. "We want to expand the successful collaboration with science libraries to include all the university libraries." This would create synergies for all Swiss university libraries and increase standardised services for customers. ■

http://www.library.ethz.ch/en/
https://blogs.ethz.ch/slsp/ (in German only)

Cooperation between libraries saves resources.

A DENSER INFRASTRUCTURE

Vision for Hönggerberg campus in 2040

ETH Zurich is planning to expand its infrastructure and facilities within the current campus boundaries. The vision set out for 2040 is an attractive campus with a city neighbourhood feel that serves as a base for teaching, research and the transfer of knowledge, while leaving ample space for social and leisure activities.

To make sure ETH can continue to develop this important space, the municipal council of the city of Zurich will transfer the Master Plan 2040 into updated special building regulations and adapt the municipal building and zoning regulations. Following an amendment to the cantonal structure plan entry, ETH will once again have room for expansion.

This vision is based on the ETH Campus Hönggerberg 2040 Master Plan drawn up by ETH Zurich together with the city and canton of Zurich. This envisages a consolidation of buildings within existing boundaries, so as to preserve the surrounding landscape and green spaces.

Four new strategically placed high-rise buildings will shape the character of the campus. The central Wolfgang-Pauli-Strasse will be transformed into a lively boulevard with cafés, shops and exhibition space on the ground floor. Shops and public squares will complete the picture, making the campus an attractive area for ETH members and visitors.

"A key component of this infill development is the positioning of the new high-rise buildings on the central boulevard," explains Ulrich Weidmann, ETH Vice President for Human Resources and Infrastructure. "That will allow us to expand the green spaces on the campus and preserve the protected research buildings and existing gardens." ■

www.ethz.ch/masterplan-2040

Artist's impression of the extended Flora-Ruchat-Roncati Garden for Campus Hönggerberg 2040.

New professorships

FULL PROFESSORS

New appointments

Professor Tom Avermaete,
History and Theory of Urban Design (1.9.2018), D-ARCH, formerly Full Professor at Delft University of Technology, Netherlands

Professor François Charbonnet,
Architecture and Design (1.6.2018), D-ARCH, formerly Partner and Architect at "Made in", Geneva, Switzerland

Professor Emanuel Christ,
Architecture and Design (1.4.2018), D-ARCH, formerly Partner and Architect at Christ & Gantenbein AG, Basel, and guest lecturer at Harvard University, Cambridge, USA

Professor Jacob Corn,
Genome Biology (1.10.2018), D-BIOL, formerly Scientific Director at the Innovative Genomics Institute (IGI), Berkeley, and Adjunct Assistant Professor at the University of California, Berkeley, USA

Professor Christoph Gantenbein,
Architecture and Design (1.4.2018), D-ARCH, formerly Partner and Architect at Christ & Gantenbein AG, Basel, and guest lecturer at Harvard University, Cambridge, USA

Professor Patrick Heiz,
Architecture and Design (1.6.2018), D-ARCH, formerly Partner and Architect at "Made in", Geneva, Switzerland

Professor Daniel Razansky,
Biomedical Imaging (1.8.2018), D-ITET, formerly Professor of Molecular Imaging Engineering at the Technical University of Munich, Germany

Professor Alexander Stremitzer,
Law, Economics, and Business (1.5.2018), D-GESS, formerly Professor at the University of California, Los Angeles, USA

Professor Zhendong Su,
Computer Science (1.8.2018), D-INFK, formerly Professor at the University of California, Davis, USA

ASSOCIATE PROFESSORS

Promotions

Professor Philippe Block,
Architecture and Structure (1.1.2018), D-ARCH, formerly Associate Professor at ETH Zurich, Switzerland

Professor Olga Sorkine Hornung,
Computer Science (1.1.2018), D-INFK, formerly Associate Professor at ETH Zurich, Switzerland

Professor Laurent Stalder,
Theory of Architecture (1.6.2018), D-ARCH, formerly Associate Professor at ETH Zurich, Switzerland

Professor André Studart,
Complex Materials (1.10.2018), D-MATL, formerly Associate Professor at ETH Zurich, Switzerland

New appointments

Professor Whitney Behr,
Structural Geology and Tectonics (1.7.2018), D-ERDW, formerly Assistant Professor at the University of Texas at Austin, USA

Professor Andreas Fichtner,
Seismology and Wave Physics (1.1.2018), D-ERDW, formerly Assistant Professor (tenure track) at ETH Zurich, Switzerland

Professor Otmar Hilliges,
Computer Science (1.6.0218), D-INFK, formerly Assistant Professor (tenure track) at ETH Zurich, Switzerland

Professor Dirk Mohr,
Computational Modelling of Materials in Manufacturing (1.1.2018), D-MAVT, formerly Assistant Professor (tenure track) at ETH Zurich, Switzerland

Professor Bill Morandi,
Synthetic Organic Chemistry (1.7.2018), D-CHAB, formerly group leader at the Max Planck Institute for Coal Research, Mülheim, Germany

Professor Elli Mosayebi,
Architecture and Design (1.8.2018), D-ARCH, formerly Professor at the Technical University of Darmstadt, Germany

Professor Sai Reddy,
Systems and Synthetic Immunology (1.8.2018), D-BSSE, formerly Assistant Professor (tenure track) at ETH Zurich, Switzerland

ASSISTANT PROFESSORS

New appointments

Professor Milica Topalovic,
Architecture and Territorial Planning (1.8.2018), D-ARCH, formerly Assistant Professor (tenure track) at ETH Zurich, Switzerland

Professor Lenny Winkel,
Inorganic Environmental Geochemistry (1.4.2018), D-USYS, formerly Assistant Professor at ETH Zurich and a group leader at Eawag, Switzerland

Professor Elliott Ash,
Law, Economics, and Data Science (1.7.2018), D-GESS, formerly Assistant Professor (tenure track) at the University of Warwick, Coventry, UK

Professor Ori Bar-Nur,
Regenerative and Movement Biology (1.2.2018), D-HEST, formerly postdoctoral researcher at Harvard Medical School, Boston, Massachusetts, USA

Professor Andrea Burden,
Pharmacoepidemiology (1.5.0218), D-CHAB, formerly postdoctoral researcher at the University of Maastricht, Netherlands

Professor Cyril Chelle-Michou,
Mineral Resource Systems (1.12.2018), D-ERDW, formerly postdoctoral researcher at the University of Bristol, United Kingdom

Professor Olga Fink,
Intelligent Maintenance Systems (1.10.2018), D-BAUG, formerly group leader at Zurich University of Applied Sciences, Winterthur, Switzerland

Professor Daniel Hall,
Innovative and Industrial Construction (1.1.2018), D-BAUG, formerly doctoral student at Stanford University, California, USA

Professor Taekwang Jang,
Analogue and Mixed Signal Interfaces (1.8.2018), D-ITET, formerly postdoctoral researcher at the University of Michigan, USA

Professor Victor Mougel,
Inorganic Chemistry (1.12.2018), D-CHAB, formerly scientist at the Collège de France, Paris, France

Professor Rafael Polania,
Decision Neuroscience (1.2.2018), D-HEST, formerly postdoctoral researcher at the University of Zurich, Switzerland

Professor Stanisa Raspopovic,
Neuroengineering (1.4.2018), D-HEST, formerly Chief Technology Officer at the EPFL spin-off SensArs Neuroprosthetics, Switzerland

Professor Lesya Shchutska,
Experimental Particle Physics (1.1.2018), D-PHYS, formerly research associate at ETH Zurich, Switzerland

Professor Emma Wetter Slack,
Food Immunology (1.6.2018), D-HEST, formerly senior scientist at ETH Zurich, Switzerland

ADJUNCT PROFESSORS

Professor Arthur Gessler,
D-USYS, lecturer at ETH Zurich, Switzerland

Professor Markus Künzler,
D-BIOL, senior scientist at ETH Zurich, Switzerland

Professor Michael Leunig,
D-HEST, lecturer at ETH Zurich, Switzerland

Professor Katharina Maniura,
D-HEST, lecturer at ETH Zurich, Switzerland

Professor Kai Udert,
D-BAUG, lecturer at ETH Zurich, Switzerland

Professor Martin Wörter,
D-MTEC, senior scientist and *Privatdozent* at ETH Zurich, Switzerland

Professor Nicola Zamboni,
D-BIOL, senior scientist at ETH Zurich, Switzerland

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

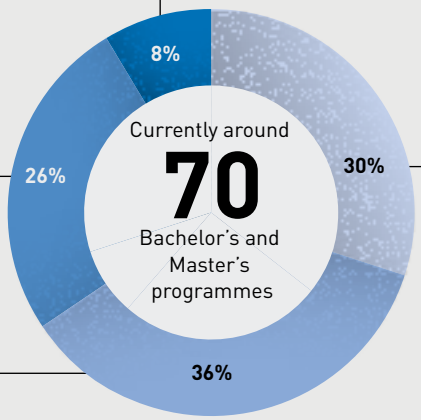
High quality assured through autonomy

To maintain its high quality standards, ETH continuously updates its range of degree programmes (2014–2018):

New degree programmes designed from scratch and implemented, such as the Bachelor's degree in human medicine and the Master's degrees in data science and quantum engineering

Major revisions to existing degree programmes as part of **degree programme initiatives**

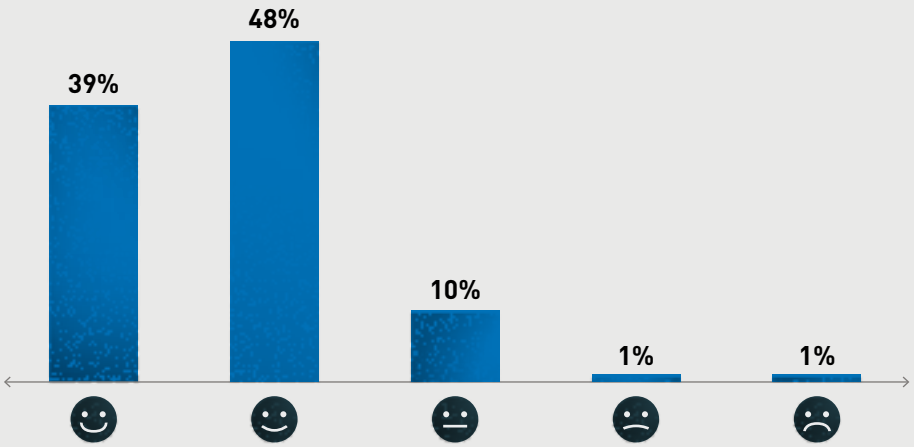
Degree programmes with **amended regulations**



Degree programmes with no substantial changes, but with **ongoing minor updates**

Satisfaction almost 90 percent

87 percent of ETH graduates rate their Master's programme as good to very good (graduating cohort 2016, survey by the Federal Statistical Office one year after graduation).

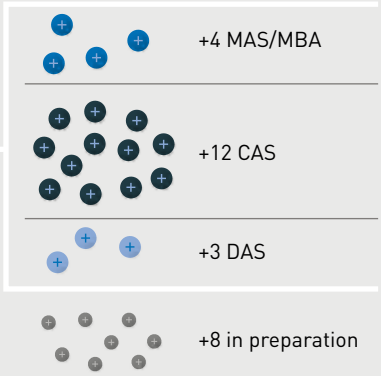


ETH Zurich's continuing education programmes

The continuing education programmes – MAS/MBA, CAS and DAS – as well as the further education courses and e-learning offering are revised proactively in accordance with the requirements of managers and specialists.

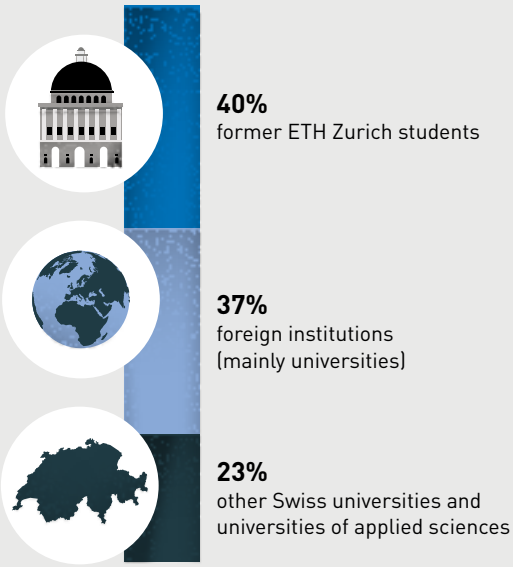
Currently around 50 MAS/MBA, CAS, DAS courses

New programmes (2013–2018):



Origin of continuing education students

MAS/MBA (2014–2018)



40%
former ETH Zurich students

37%
foreign institutions (mainly universities)

23%
other Swiss universities and universities of applied sciences

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. On 1 January 2019 there was a change in the Executive Board: Joël Mesot succeeded Lino Guzzella as the new President of ETH Zurich.

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 monitored 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 top-ranking universities in energy, environmental and sustainability research. As a leading institution in this area, ETH today integrates the principles of sustainable development in its research and teaching activities, as well as on campus and in its dialogue with society. Its sustainability report, published at the same time as the annual report, provides full details of its activities in this area.

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 form of quality assurance 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 ordinances on study at the university; establishing or closing down departments and other units, such as interdepartmental centres of excellence; and 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 associate vice presidents with special tasks assigned to them. Ombudspersons, or trusted intermediaries in the case of research-specific disputes, advise and support ETH members when conflicts occur.

Academic departments

The academic departments are responsible for their own strategic planning, running their degree programmes and coordinating their research. In addition to this, several departments provide teaching services for degree programmes 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 departments' other teaching staff, 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 the areas of scientific research, 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.

The relevant Department Conference decides on academic regulations, which are then approved by the Executive Board. The regulations are drawn up by the Teaching Commission, an advisory body 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 degree programme 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 addresses 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 studying 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 academic departments to take account of altered circumstances.

Organisation chart 2018

As of 31 December 2018

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 and 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 2018

As of 31 December 2018

Detlef Günther (1963) has been Assistant Professor (from October 1998), Associate Professor (from July 2003) and Full Professor (from 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 a Sulzer 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 Lino Guzzella was Rector of ETH Zurich and was President of the university from January 2015 to the end of 2018.

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 2018, the salaries of the five members of the Executive Board, including the employer's social security contributions, came to CHF 2.14 million (last year: CHF 2.08 million). The total sum includes CHF 0.38 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 (as of 31 December 2018)

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 SUS-Tech 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: Member of the University Council of the University of Cologne, Guest Lecturer on the CAS University Leadership and Governance at Universities programme at the University of Zurich

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 the disabled)

PERSONNEL CHANGES IN THE EXECUTIVE BOARD

Joël Mesot – ETH Zurich's new President

Joël Mesot succeeded Lino Guzzella as President of ETH Zurich on 1 January 2019.

On 1 January 2019, Joël Mesot succeeded Lino Guzzella as the new ETH President. The 54-year-old has been Director of the Paul Scherrer Institute (PSI) since 2008 and holds a joint professorship in physics at ETH Zurich and EPFL. Mesot grew up in Geneva and studied physics at ETH Zurich, obtaining a doctorate in solid-state physics in 1992. After periods spent in France and the USA, he returned to ETH Zurich and joined PSI in 1999.

The President bears legal and political responsibility for the university and is accountable to the ETH Board for its management. He chairs the Executive Board and coordinates its activities; the other members of the Executive Board report to him. In consultation with other members of the Executive Board and on the basis of the ETH Board's strategic plan, he determines the strategy. The President also makes decisions on the budget, allocates funds to the different areas of activity (domains) of the Executive Board and to the departments, and oversees the finances for the entire university. He is responsible for appointing professors and also appoints the heads of department at the request of Department Conferences. He represents the university to the outside world; he maintains relationships with public authorities, political bodies and the general public, and is responsible for communication policy. He is in charge of the internationalisation process – the university's international positioning – and building up strategic alliances. His responsibilities also include fundraising and alumni relations.

www.ethz.ch/president
www.ethz.ch/assumption-of-office-mesot

STRENGTHENING OUR MANAGEMENT CULTURE

A more collaborative management style

Conflicts between staff and managers are inevitable – the important thing is how you deal with them. ETH Zurich is employing various measures to actively strengthen its management culture.

Around 12,000 people work at ETH Zurich, and some 1,250 of them have a management role. However, all ETH members have a part to play in shaping the university's management culture: "Management is a task that involves us all," says Ulrich Weidmann, Vice President for Human Resources and Infrastructure. Feedback from employees is therefore very important, but equally important is their willingness to see well-intentioned criticism from their managers as a positive thing. In difficult situations, help is available from the HR department. "With so many people, problems and conflicts are inevitable. The important thing is how you deal with them," says Director of Human Resources Lukas Vonesch. "Managers need to identify conflict situations early on, find out the causes and come up with a process for solving the problem. Direct conversations are always the best way, but there are situations where even the most experienced managers need support from colleagues or specialists in HR. Asking for help is nothing to be ashamed of – it is a sign of strong leadership."

Conflicts can, however, also be an indication of misconduct. If it is not possible to have an open conversation with those involved, the HR Department can help. All advice is confidential. In addition to individual consultations, coaching and mediation, the HR department also organises management courses.

The supervision of doctoral students is another important issue: "I know from experience how rewarding a collaborative partnership between doctoral student and professor can be for both parties," says former ETH President Lino Guzzella, who goes on to stress that "ETH is a network of experts. Hierarchies are not the be-all and end-all for us – what matters is that our interactions are based on cooperation, respect and trust, that we discuss any issues that arise and that we give employees plenty of freedom, responsibility and room to grow."

Improvements already made

ETH Zurich is currently working on a comprehensive management project involving six subprojects: Appointments, Onboarding of professors, Doctorate, Postdoctorate, Early detection and Dealing with alleged misconduct.

Some measures have already been implemented: for example, a case manager has been appointed to coordinate the handling of ongoing investigations. The number of ombudspersons has been

increased from two to three, and their appointment is more independent now that candidates are proposed by the University Assembly. A year ago, the number of trusted intermediaries was increased from one to two in order to assure research integrity and deal with cases of suspected scientific misconduct. In addition, a separate Commission for Good Scientific Practice (GSP) was set up, which supports the Executive Board in furthering GSP culture at ETH Zurich. Supervision provided to doctoral students will be improved, partly through regular on-site meetings and consistent implementation of planned control mechanisms. There are also currently internal discussions about the introduction of personal development plans and a system of multiple supervision for doctoral students.

During the procedure for evaluating and appointing new professors – one of the most important tasks of the ETH President – more emphasis will be placed in future on the candidate's management skills. Onboarding procedures will be improved as well: communication before and after the new professors start work will be stepped up, the Executive Board's welcome event will be expanded, and online modules and workshops provided so that incoming professors are better familiarised with the rules, customs and values of ETH Zurich. "Careful selection of new colleagues and ensuring their optimal integration are key elements for the university's success and reputation. Devoting more time and attention to these tasks uses far fewer resources than time-consuming HR development measures to limit damage in cases of mismanagement," Guzzella stresses.

www.ethz.ch/leadership-culture

EXPLORING NEW DIRECTIONS

New ideas for ETH+

The Executive Board has launched the ETH+ initiative to encourage ideas that bring together different disciplines and accelerate the drive towards promising research areas. The number of professorships will be expanded to provide the required capacity. Nine ETH+ projects have already been approved.

ETH Zurich's Executive Board launched the ETH+ initiative at the end of 2017. The goal is to quickly develop greater capacity, and in particular to open up new fields of knowledge at the intersections between disciplines. At its core lies an increase in new professorships in future-oriented areas. But the "+" sign stands not only for an increase in the number of professors, but above all an increase in quality. "If we want to continue to be a driving force for Switzerland and its innovative capacity, and to keep pace with the world's best, we must invest more in top talent," says Lino Guzzella, ETH President up to the end of 2018.

ETH+ is generating a lot of interest from all areas of the university.

The Executive Board launched an ETH-wide tender based on the conviction that the ETH community itself best knows in which areas the greatest potential lies. In total, 68 idea sketches were submitted up to May 2018, with all academic departments taking part. Administrative units, the Association of Students (VSETH) and the Academic Association of Scientific Staff (AVETH) also submitted proposals.

"ETH+ has developed an unbelievably positive dynamic. Employees have joined forces beyond subject boundaries and generated outstanding ideas. This shows the enormous potential that ETH has to offer," Guzzella says.

In June 2018, ten groups were invited to present a full proposal, and nine were then approved for implementation. The chosen projects fulfilled the criteria of originality, interdisciplinarity and complementary interfaces, and were also able to show that the outcome of the overall project will be greater than the sum of the results from the individual subprojects.

One of the initiatives approved is ETHeart, which aims to achieve a technological revolution in cardiovascular therapy. Another initiative creates a new professorship for robotic materials. This is designed to fill the gap between robotics and materials science, and to develop smart materials. A call for the submission of the second round of idea sketches was made in October 2018.

www.ethz.ch/ethplus-en

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 monitored 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 to safeguard 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 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 periodically reports 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.

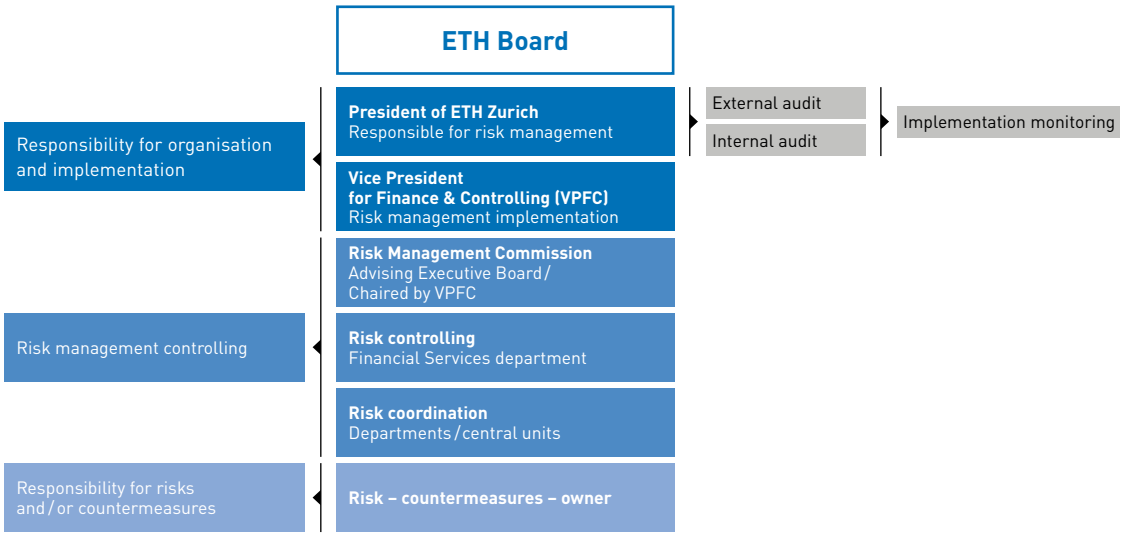
Organisation and process

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 the reporting, assessment, minimisation and controlling of risk, 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 one or more officers 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, measures such as 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, assures adherence to internal and external rules, and minimises 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. As an independent external auditor, the Swiss Federal Audit Office verifies the existence of the ICS implemented at ETH Zurich as part of the statutory audit of the annual financial statements.



Core risks

Risks with potentially damaging impacts on the finances or reputation of ETH as a whole 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 in the long run is therefore weighted correspondingly highly.

- A **loss of financial resources** due to a significant reduction in allocated federal funding or a sustained 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, for example 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 carries the risk of 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 is promoting good practices in the areas of supervision and mentoring by clearly communicating ETH's culture, values and expectations, especially **concerning the education and management of undergraduate / doctoral students and staff;** making various adjustments in the doctoral and postdoctoral area; as well as implementing measures for early detection and intervention in conflict situations.

- All of 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. A panel of technical experts and the holder of the newly created role of Chief Information Security Officer (CISO) regularly review the measures implemented to achieve the protection targets defined as part of IT security, and adjust them as necessary.

- 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 many 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 federal government** 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 new-build or modernisation project, with the aim of averting major incidents.

- **Adequate premises, both in terms of quantity and quality,** are crucial for teaching and research and allow growth targets to be set. Partial or total loss of infrastructure within a room or an entire building can pose a threat to ETH Zurich's teaching and research activity; lack of space and viable building plots jeopardise the achievement of growth targets.

Introduction of subject-specific e-learning modules at ETH Zurich: In addition to modules for the areas of Professional Expenses and Procurement, further e-learning modules are currently being developed to improve the skills of ETH members. They include Export Control, Integrity and Ethics in Research, Teaching, SSHE, IT Security and Data Protection.

SUSTAINABILITY IN PRACTICE

A long tradition of sustainability

Around 30 years ago, ETH Zurich was the first European university to establish a department dedicated to environmental sciences. This laid the foundation for a long-term commitment. Today the university is an international centre of excellence and a flagship for sustainability research, incorporating the principles of sustainable development in the core areas of research, education, campus, and dialogue with society.

At ETH Zurich, sustainability is embedded in decision-making at the highest level, with the President's office. It is a strategic objective to maintain and expand the university's international reputation in the fields of environmental, climate and nutrition research. As well as activities carried out within the academic 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 research activities, ETH Zurich furnishes the scientific and technical knowledge required for a sustainable society. To highlight and support this commitment, ETH Zurich has defined sustainability as one of five focal themes in its Strategy and Development Plan. In addition to the broad spectrum of cutting-edge research in the academic departments, ETH Zurich can draw on the interdisciplinary expertise of its various competence centres in order to address major societal challenges such as future cities and the sustainable design of living spaces, food security, energy supply and climate change.

2 **Education:** ETH Zurich trains the next generation of specialists and experts to ensure they actively integrate sustainability aspects into their professional lives. In past decades, ETH Zurich has not only developed internationally acclaimed study programmes and other teaching formats, but has also established new departments and institutes to teach sustainability knowledge to its students. Moreover, ETH Zurich is keen to encourage intellectual agility by providing its students with tools enabling them to tackle socially and ethically relevant aspects in their studies, in their professional work and as responsible members of society.

3 **Campus:** On campus, ETH Zurich lives and promotes the principles of sustainable development with respect to social, environmental and financial aspects. As an employer, ETH Zurich aims to provide the best possible working conditions, including enabling and maintaining a participatory, respectful and diverse environment. The university endeavours to serve as a "living lab" which develops, implements and tests pioneering solutions that preserve natural resources and reduce environmental impacts. Finally, as a publicly funded university, ETH Zurich places great value on transparent budgeting and controlling, financial accountability, and risk management.

4 **Dialogue:** ETH regularly informs the public about its latest research findings. It makes its scientific knowledge publicly available so as to make a significant contribution to the public debate about aspects of sustainable development. In accordance with its mandate, ETH Zurich has developed a range of formats and communication tools to provide information to the public in an accessible and comprehensible way. The university also provides a number of services for the federal government and makes its expertise available for decisions to be taken based on scientific facts.

Transparency and credibility

ETH Zurich's reporting also reflects its commitment to sustainable development. 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 comprehensively on ecological, economic and social aspects. The current sustainability report for 2017/2018 was published at the same time as this ETH Zurich 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.

ETH Zurich has compiled all its sustainability reports to date 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). The latest report also describes how ETH Zurich is helping to achieve the Sustainable Development Goals (SDGs) of the United Nations. These sustainability reports are notable for their high degree of stakeholder involvement; for their local, national and global reach; and for being certified by external auditors.

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

Sustainability and mobility at ETH

For members of the ETH community, action on climate change inevitably focuses on mobility as well. Air travel is responsible for more than half the university's greenhouse gas emissions, which have increased overall during the past ten years.

The Air Travel Project is one of the measures that the Mobility Platform has initiated. To reduce emissions from air travel, the academic departments have set themselves reduction targets for the period 2019 to 2025 as part of a broadly participatory process and have also defined suitable measures. The targets relate to air travel by staff and students as part of their curriculum. A new emissions-monitoring system will come into use in 2019 in order to measure air travel emissions far more accurately than previously, with data recorded for each department. The Air Travel Project will be subject to a mid-term evaluation in 2022, three years after it begins. A doctoral student will also observe, document and analyse the project as part of her thesis. The overall project aim is to embark on a reduction path that is compatible with excellence in science and creates the best possible career opportunities for researchers. Around the campus, the Mobility Platform initiative has launched or extended e-bike sharing schemes from providers such as smide, LimeBike and PubliBike. ETH members therefore have access to a wide range of attractively priced offers for renting bikes.

To ease congestion for those commuting to the Hönggerberg campus during rush hour, ETH has arranged and funded extra buses to run at peak times on the 80 bus route. In addition, a concept for a charging infrastructure for electric vehicles has been commissioned, and the first charging stations have been installed as part of a scientific study and pilot service using e-Golfs sponsored by Europcar.

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

Composition of total revenue (2018)

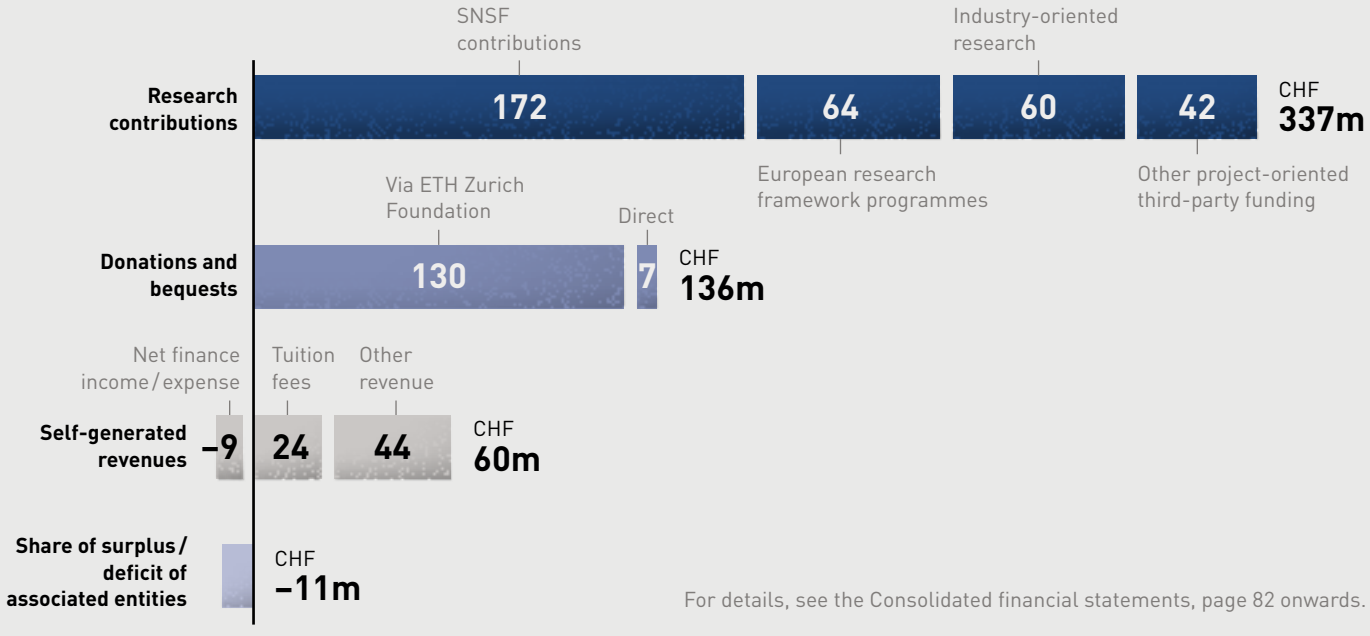
Federal financial contribution
CHF
1,326m

CHF
1,848m
Total revenues

72%
18%
7%
3%
28%

Third-party funding
incl. surplus / deficit of associated entities
CHF
522m

Third-party funding, composition



For details, see the Consolidated financial statements, page 82 onwards.

Finance

2018 was a period of sustained growth for ETH Zurich. The number of students continued to increase, new professors were appointed and selective investments were made. Consolidated operating expenses rose by 3 percent year on year to 1,795 million Swiss francs in total, reflecting current developments. Total consolidated revenue declined by 2 percent to 1,848 million Swiss francs despite a remarkable 14 percent rise in mostly dedicated donations and research contributions.

The university's independence is a vital element when it comes to competing against other leading institutions worldwide and keeping its place at the top of global rankings. A long-term, sustainable financial policy is therefore essential. This is based on a financial plan covering a period of several years and a long-term approach to balance sheet management. In this context, it is vital for ETH Zurich to maintain its freedom in teaching and research as well as its strategic and financial scope. The total contribution from the Federal Government (global budget) provides a reliable basis on which to do so. Targeted diversification of funding sources, together with the reserves that have been accrued through responsible funding management, allow for more reliable planning and help to keep the university on a sustainable track. It also allows ETH Zurich to act on its own initiative, quickly taking up cutting-edge topics of social relevance such as digitalisation and personalised medicine and addressing them in an interdisciplinary setting, as is happening currently with the ETH+ initiative.

ETH Zurich's annual consolidated financial statements clearly present the financial position, financial performance and cash flows on an accrual basis. They were prepared in accordance with International Public Sector Accounting Standards (IPSAS).

DEVELOPMENT AND EXPANSION

Current developments

The number of students increased again, rising by 4 percent compared with 2017, to 21,397. This sets another record and brings the total increase over the last 10 years to 50 percent. The growing student numbers, in combination with its mission to deliver high quality and excellence in teaching and research, present ETH Zurich with continuous challenges. ETH Zurich meets these challenges by developing and expanding teaching and research capacity and making selective investments in infrastructure. It uses the third-party funding reserves on hand to create new professorships in cutting-edge fields of knowledge through initiatives such as ETH+ and thus consolidate its position at the top of global university rankings. The refine project marked the start of the work to upgrade ETH Zurich's finance and resource platform. As well as migrating the ERP platform to the latest generation (SAP S4/HANA) and further developing financial governance, management accounting and financial accounting have been better coordinated, laying the foundations for transparent and dynamic financial management.

To keep ETH Zurich on a sustainable track, it is extremely important that the total federal contribution remains stable and the university's funding base is diversified. By operating a rigorous quality policy and ensuring that relevant rules and procedures are followed, ETH Zurich ensures that funding is managed in a responsible and transparent manner.

Refine project brings changes in financial management

On 9 January 2019, ETH Zurich's refine project successfully commissioned a technically and conceptually advanced, second-generation resource and finance platform. The stated and fulfilled aim of refine was to bring ETH Zurich's finance, human resources and logistics system into line with users' current and future needs, as well as with increasing regulatory requirements, while at the same time modernising the underlying technology.

Not only was the existing, almost 20-year-old SAP R3 platform replaced with the latest SAP product generation, the project also paved the way for important design changes to the financial management system. One key element here is the transition made from "cash" to "accrual" accounting, where the use of resources is presented in the period of the economic benefits rather than in the period of the expenditure.

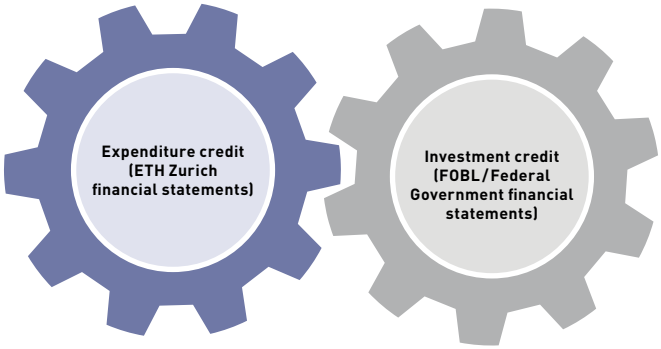
While specific aspects of financial governance were further developed in line with requirements, the long-established principles of internal financial management remain in place. There is now more multi-period planning information and greater flexibility, which supports the departments in their responsibility for integrated resource management. This enables a more economical approach to financial management, as budgeted and actual costs can be compared.

In parallel to the system migration, ETH Zurich's revised financial regulations entered into effect in January 2019. These govern financial workflows and responsibilities under the adapted financial management system and provide a solid basis for it.

www.ethz.ch/refine-en

FUNDING OVERVIEW

Global budget, sources and use of funds



At a political level, the ETH Domain is managed through strategic objectives set by the Federal Council, the term and content of which are tailored to the Federal Government-approved funding. Based on the strategic objectives, the ETH Board enters into target agreements with the two federal institutes of technology and the four research institutions and allocates the federal funds. The federal financial contribution granted to ETH Zurich (global budget) covers basic teaching and research equipment as well as its share of building investments for government-owned property used by ETH Zurich.

In 2018, the share of the total federal financial contribution (global budget) granted to ETH Zurich by the ETH Board amounted to 1,300 million Swiss francs. In the course of planning and budgeting, the share of the building shell (new buildings, renovations) is separated for accounting purposes 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)

	2018	2017	Absolute change
Federal financial contribution	**1,300**	**1,297**	**3**
Of which expenditure credit (ETH Zurich)	1,177	1,201	– 24
Of which investment credit – expenditure (FOBL / Federal Government)	84	96	– 13
Of which investment credit – remainder [1] (FOBL / Federal)	40	–	40

[1] Due to delays caused by a complaint in a tender procedure brought before the Federal Administrative Court, it was not possible to make planned expenditures on the construction of the new building in Basel for the Department of Biosystems Science and Engineering as scheduled. Following parliamentary approval, dedicated reserves will be recognised in the FOBL's financial statements for the 2019 reporting period from the portion of the investment credit remaining as a result. These reserves are being recognised for the first time and in accordance with the Federal Act on the Federal Financial Budget. The remainder of the investment credit is not part of ETH Zurich's total revenue in 2018.

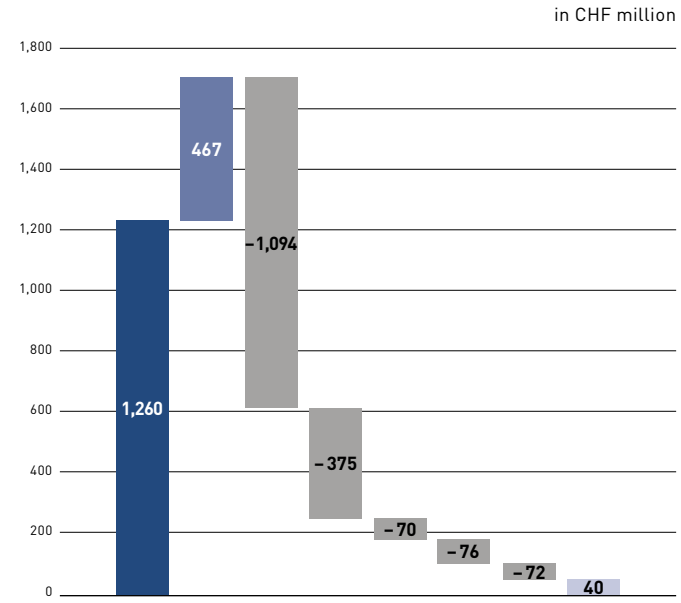
The consolidated third-party funding received by ETH Zurich in 2018 amounted to 467 million Swiss francs and came primarily from project-oriented research contributions, grants and self-generated revenues. Excluding the dedicated reserve for the remainder of the investment credit, ETH Zurich's total income amounted to 1,727 million Swiss francs.

The funds available are used, firstly, to cover personnel expenses for teaching, research and administration and, secondly, for construction spending, other operating expenses and investments in movable assets. This produced consolidated net income of 40 million Swiss francs. Third-party funding not used immediately in 2018 was added to financial assets.

In 2018, construction spending on properties amounted to a total of 142 million Swiss francs and was financed through the investment credit (84 million Swiss francs), the expenditure credit (57 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 177 buildings and facilities and 69 plots of land. The carrying amount of the plots of land was 691 million Swiss francs at the end of 2018. The buildings were stated in the accounts at a value of 1,350 million Swiss francs at the end of 2018 and their replacement cost (gross cost) was 3,565 million Swiss francs.

Composition and use of income (CHF 1,727 million)



Expenditure credit and investment credit (excl. credit remainder) 1,260

Third-party funding (consolidated) 467

Use (consolidated)

Personnel expenses – 1,094

Other operating expenses excl. construction spending (not capitalised) – 375

Construction spending (not capitalised) – 70

Investments excl. property (capitalised) – 76

Construction investments incl. leasehold improvements (capitalised) – 72

Net income (consolidated) [1] 40

[1] Consolidated net income (40 million Swiss francs) is 13 million Swiss francs lower than the consolidated surplus in accordance with IPSASs (53 million Swiss francs) due to specific accounting requirements (mainly revenues on an accrual basis, effects of IPSAS 39 and the share of surplus or deficit of associated entities).

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 a Public Sector Construction and Property Service, the ETH Board coordinates the management of the real estate in accordance with the ETH Law 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).

RESPONSIBLE FUNDING MANAGEMENT

Selective diversification makes for a sustainable funding base

The federal financial contribution (global budget) provides ETH Zurich with a solid and essential source of funding. As a share of total income (2018: 1,260 million Swiss francs), third-party funding (2018: 467 million Swiss francs) rose from 15 percent in 2000 to 27 percent in 2018, illustrating 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.

On average over the last five years, over 70 percent of all third-party funding has come from competitive research funding projects. The university's sources of income include national research funding organisations such as the Swiss National Science Foundation (SNSF) and Innosuisse, EU Framework Programmes (Horizon 2020) and collaborations with industry. Projects with the Federal Government (special funding of applied research), cantons and local authorities, and various international organisations are also of importance.

Grants (donations, legacies / bequests) made up just over 10 percent of third-party funding on average over the last five years. These funds 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 plays an important role as an intermediary between donors and ETH Zurich.

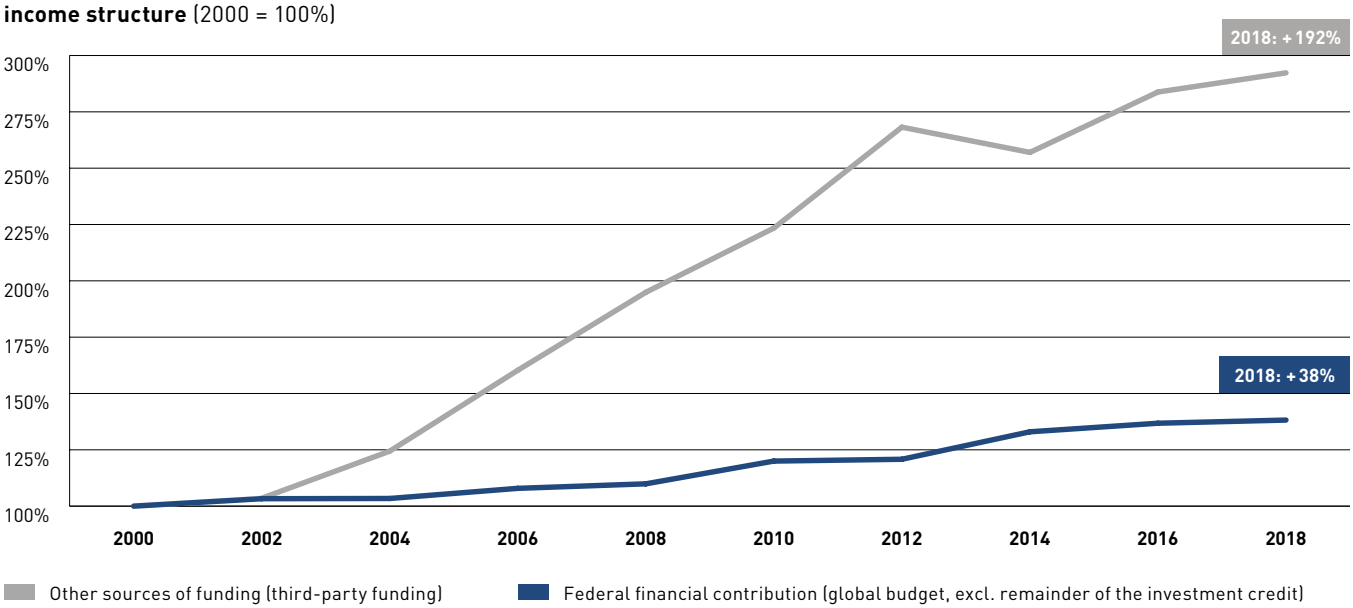
Finally, just under 20 percent of the third-party funding was attributable to self-generated revenues. As well as tuition fees (including various utilisation fees), these include various items of service revenue and other revenue.

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 funding organisations, for example, and considering the additional costs ETH Zurich 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. Moreover, 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.

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



Excellence Scholarship supports great minds: image used in the campaign by the ETH Zurich Foundation.

ETH Zurich Foundation acts as an independent intermediary

The ETH Zurich Foundation is an independent, non-profit organisation that promotes teaching and research at ETH Zurich. As ETH Zurich's annual consolidated financial statements are prepared in accordance with IPSAS, it is included in those financial statements as an associated entity. The funds it allocates to ETH Zurich are primarily charitable donations entrusted to it by companies, foundations and private individuals. These are mainly used for selected projects within the strategic initiatives set by the ETH Zurich Executive Board. ETH Zurich spin-offs and research institutions may also receive funding. Through its activities, the ETH Zurich Foundation helps to maintain and extend ETH Zurich's high ranking among international universities.

The ETH Zurich Foundation acts as an independent intermediary between ETH Zurich and donors. Its commitment to performing an important quality assurance role, ensuring that funding is managed responsibly, is attractive to both donors and beneficiaries. The ETH Zurich Foundation Board is made up of 13 prominent representatives from industry and research, only two of whom are members of ETH Zurich. When accepting funds, the ETH Zurich Foundation follows its Code of Conduct, thereby ensuring that freedom in teaching, conducting research and publishing is guaranteed at all times. The federal contributions are therefore judiciously supplemented with private funding raised by the ETH Zurich Foundation. You can find further information at **www.ethz-foundation.ch/en/.**

FINANCIAL ACCOUNTING AND REPORTING IN ACCORDANCE WITH IPSAS

Annual consolidated financial statements in brief

The annual consolidated financial statements were prepared in accordance with International Public Sector Accounting Standards (IPSAS). ETH Singapore SEC Ltd. and the Rübel Geobotanical Research Institution Foundation are consolidated in the annual financial statements. The ETH Zurich Foundation and several other foundations are reported as investments in associated entities.

A consolidated surplus of 53 million Swiss francs was reported for 2018 (a decrease of 84 million Swiss francs or 61 percent compared with the previous year).

The consolidated operating revenue generated in 2018 amounted to 1,868 million Swiss francs (an increase of 17 million Swiss francs or 1 percent compared with the previous year). The total federal contribution, which under IPSASs is made up of the federal financial contribution (in the narrower sense) and the contribution to accommodation, dropped to 1,326 million Swiss francs (a fall of CHF 41 million or 3 percent). Conversely, there was a rise mainly in revenue from third-party funding: in particular, revenue from donations and bequests climbed to 136 million Swiss francs (an increase of 54 million Swiss francs or 65 percent). Revenue from research contributions was up slightly on the prior-year figure (by 11 million Swiss francs or 3 percent) to 337 million Swiss francs.

Consolidated operating expenses increased to 1,795 million Swiss francs in 2018 (a rise of 47 million Swiss francs or 3 percent compared with the previous year). This increase was driven primarily by higher other operating expenses and personnel expenses. The latter increased due in particular to higher wages and salaries (up by 24 million Swiss francs or 3 percent) as a result of the rise in average full-time equivalents by 247 FTEs (3 percent) to 9,528 FTEs.

Total consolidated net assets rose by 134 million Swiss francs (5 percent) to 2,703 million Swiss francs at the end of 2018. Here, liabilities were up by 204 million Swiss francs, mainly because of the increase in net defined benefit liabilities. Equity, on the other hand, declined by 70 million Swiss francs to 689 million Swiss francs due to the negative trend in the valuation reserves (cumulative actuarial losses on the defined benefit liability of 123 million Swiss francs) and the reduction of 57 million Swiss francs in free reserves. Conversely, dedicated reserves (earmarked, among other things, for donations and bequests, teaching and research projects and election commitments to newly appointed professors) rose by 175 million Swiss francs. Overall, this resulted in a reduction in the equity ratio to 25 percent at the end of 2018 (previous year: 30 percent).

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

Consolidated financial statements

Consolidated statement of financial performance 84

Consolidated balance sheet 85

Consolidated statement of changes in equity 86

Consolidated cash flow statement 87

Notes to the consolidated financial statements 88

General principles 88

Accounting policies 89

Notes 95

Total federal contribution | 01 95

Tuition fees and other utilisation fees | 02 95

Research contributions, mandates and scientific services | 03 95

Donations and bequests | 04 96

Other revenue | 05 96

Personnel expenses | 06 97

Other operating expenses | 07 98

Transfer expenses | 08 98

Net finance income/expense | 09 99

Cash and cash equivalents | 10 99

Receivables | 11 100

Inventories | 12 101

Prepaid expenses and accrued income | 13 101

Investments in associated entities and joint ventures | 14 102

Property, plant and equipment and intangible assets | 15 103

Financial assets and loans | 16 104

Co-financing | 17 105

Current liabilities | 18 105

Financial liabilities | 19 105

Accrued expenses and deferred income | 20 106

Provisions | 21 107

Net defined benefit liabilities | 22 107

Dedicated third-party funds | 23 113

Financial risk management and additional information about financial instruments | 24 114

Contingent liabilities and contingent assets | 25 118

Financial commitments | 26 118

Operating leases | 27 119

Remuneration of key management personnel | 28 119

Relationships with controlled and associated entities | 29 119

Events after the reporting date | 30 121

Report of the statutory auditor 122

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	2018	2017
Federal financial contribution		1,177	1,201
Federal contribution to accommodation		149	166
Total federal contribution	1	1,326	1,367
Tuition fees and other utilisation fees	2	24	24
Swiss National Science Foundation (SNSF)		124	132
Swiss Innovation Agency (Innosuisse) [1]		22	23
Special federal funding of applied research		26	23
EU Framework Programmes for Research and Innovation (FP)		64	64
Industry-oriented research (private sector)		60	49
Other project-oriented third-party funding (incl. cantons, municipalities, international organisations)		42	35
Research contributions, mandates and scientific services	3	337	326
Donations and bequests	4	136	83
Other revenue	5	44	51
Operating revenue		**1,868**	**1,850**
Personnel expenses	6	1,133	1,115
Other operating expenses	7	536	515
Depreciation	15, 17	104	98
Transfer expenses	8	23	21
Operating expenses		**1,795**	**1,748**
Operating result		**72**	**102**
Net finance income / expense	9	**– 9**	**21**
Share of surplus / deficit of associated entities and joint ventures	14	**– 11**	**15**
Surplus (+) or deficit (–)		**53**	**137**

1. On 1 January 2018, Innosuisse, the Swiss Innovation Agency, took over the role of the Commission for Technology and Innovation (CTI).

Consolidated balance sheet

CHF million	Note	31.12.2018	31.12.2017
Assets			
Cash and cash equivalents	10	183	192
Current receivables from non-exchange transactions	11	241	243
Current receivables from exchange transactions	11	18	14
Current financial assets and loans	16	1,011	991
Inventories	12	5	6
Prepaid expenses and accrued income	13	27	24
Total current assets		**1,485**	**1,470**
Property, plant and equipment	15	441	447
Intangible assets	15	5	3
Non-current receivables from non-exchange transactions	11	627	492
Non-current receivables from exchange transactions	11	0	0
Investments in associated entities and joint ventures	14	93	104
Non-current financial assets and loans	16	4	3
Co-financing	17	48	50
Total non-current assets		**1,218**	**1,099**
Total assets		**2,703**	**2,569**
Liabilities and equity			
Current liabilities	18	60	81
Current financial liabilities	19	0	0
Accrued expenses and deferred income	20	75	76
Short-term provisions	21	49	44
Short-term liabilities		185	201
Dedicated third-party funds	23	726	663
Non-current financial liabilities	19	19	19
Net defined benefit liabilities	22	1,056	893
Long-term provisions	21	28	34
Long-term liabilities		1,829	1,609
Total liabilities		**2,014**	**1,810**
Valuation reserves		–650	–527
Dedicated reserves		798	623
Free reserves		483	540
Co-financing	17	48	50
Reserves from associated entities	14	93	104
Accumulated surplus (+) / deficit (–)		–84	–31
Total equity		**689**	**759**
Total liabilities and equity		**2,703**	**2,569**

Consolidated statement of changes in equity

CHF million	Valuation reserves a	Dedicated donations and bequests b	Teaching and research reserves c	Infrastructure and administration reserves d	Dedicated reserves	Free reserves e	Co-financing	Reserves from associated entities f	Accumulated surplus (+)/deficit (–) g	Total equity
2018										
As of 1.1.2018	**– 527**	**389**	**177**	**57**	**623**	**540**	**50**	**104**	**– 31**	**759**
Surplus (+) or deficit (–)									53	**53**
Revaluation of net defined benefit liabilities	– 123									**– 123**
Revaluation of financial assets	0									**0**
Total items directly recognised in equity	– 123									**– 123**
Increase (+)/decrease (–) in reserves	0	96	77	3	175	– 57	– 2	– 11	– 106	**0**
Total changes	**– 123**	**96**	**77**	**3**	**175**	**– 57**	**– 2**	**– 11**	**– 53**	**– 70**
As of 31.12.2018	**– 650**	**484**	**254**	**60**	**798**	**483**	**48**	**93**	**– 84**	**689**
2017										
As of 1.1.2017	**– 816**	**358**	**180**	**51**	**590**	**404**	**52**	**90**	**13**	**333**
Surplus (+) or deficit (–)									137	**137**
Revaluation of net defined benefit liabilities	290									**290**
Revaluation of financial assets	0									**0**
Total items directly recognised in equity	289									**289**
Increase (+)/decrease (–) in reserves	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**

a The negative valuation reserves (CHF – 650 million as of 31 December 2018) mainly comprise cumulative net actuarial and investment losses on the defined benefit liability (not recognised in surplus or deficit). Details can be found in note 22.

b Dedicated donation and bequest reserves rose to CHF 484 million, as new donation agreements signed exceeded funds used (previous year: CHF 389 million). The funds presented in this item are subject to contractually specified conditions or have a contractually specified purpose.

c Dedicated teaching and research reserves rose to CHF 254 million (CHF +77 million). The rise related to new projects, mostly the ETH+ initiative. The reserve included election commitments to newly appointed professors of CHF 107 million as of 31 December 2018 (previous year: CHF 97 million).

d Dedicated infrastructure and administration reserves rose as a result of the increase in risk capital (CHF +19 million), which was partly offset by the reversal of reserves for delayed construction projects.

e 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.

f Reserves from associated entities comprise ETH Zurich's share of the equity of these legally independent entities. Changes reflect its share of the associated entities' surplus or deficit in the reporting period (see notes 14 and 29).

g 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/deficit for the period and increases/decreases in the reserves in equity.

Consolidated cash flow statement

CHF million	Note	2018	2017
Cash flows from operating activities			
Surplus (+) or deficit (–)		**53**	**137**
Depreciation	15, 17	104	98
Share of surplus / deficit of associated entities and joint ventures		11	– 15
Net finance income / expense (non-cash)		11	– 16
Increase / decrease in net working capital		– 25	– 6
Increase / decrease in net defined benefit liabilities	22	41	45
Increase / decrease in provisions (short- and long-term)	21	– 1	6
Increase / decrease in non-current receivables	11	– 131	– 55
Increase / decrease in dedicated third-party funds	23	63	13
Reclassification and other (non-cash) income		1	– 1
Cash flows from operating activities		**127**	**205**
Cash flows from investing activities			
Investments			
Purchase of property, plant and equipment	15	– 99	– 100
Purchase of intangible assets	15	– 3	– 2
Increase in co-financing	17	0	0
Increase in loans	16	– 1	0
Increase in current and non-current financial assets	16	– 48	– 98
Total investments		**– 151**	**– 201**
Divestments			
Disposal of property, plant and equipment	15	0	1
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	15	35
Total divestments		**15**	**35**
Dividends received from associated entities and joint ventures	14	0	0
Cash flows from investing activities		**– 135**	**– 165**
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		**– 9**	**40**
Cash and cash equivalents at the beginning of the period (1.1.)	10	**192**	**151**
Total cash flow		– 9	40
Cash and cash equivalents at the end of the period (31.12.)	10	**183**	**192**
Contained in the cash flows from operating activities are:			
Dividends received		3	2
Interest received		2	2
Interest paid		– 1	– 1

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 21,400 students from 120 countries, including 4,180 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 2018 to 31 December 2018. The reporting date is 31 December 2018. The reporting is prepared in Swiss francs (CHF). All figures are shown in millions of Swiss francs (CHF million) unless indicated otherwise.

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 6.3)

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).

IPSASs issued but not yet applied

The following IPSASs were issued before the reporting date. They only become effective later on and have not been early applied in these annual consolidated financial statements. The effective date is given in brackets.

IPSAS 40	Public Sector Combinations (1 January 2019)
IPSAS 41	Financial Instruments: Recognition and Measurement; replaces IPSAS 29 (1 January 2022)
IPSAS 42	Social Benefits (1 January 2022)
Various	Improvements to IPSAS, 2018 (various; as of 1 January 2019)

The effects on the annual consolidated financial statements are being systematically analysed. So far, however, no material effects on the annual consolidated financial statements are expected.

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.

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

The annual consolidated financial statements of ETH Zurich comprise the financial statements of ETH Zurich and of all entities which ETH Zurich controls directly or indirectly. The carrying amounts of investments in associated entities are also included in the consolidated financial statements.

Control means that, through its involvement with the entity, ETH Zurich has the power to direct the relevant activities of the entity and thus the ability to affect the nature and amount of benefits. At the same time, the controlling entity is exposed, or has rights, to variable benefits. ETH Zurich normally has the ability to control if it directly or indirectly holds more than 50 percent of the voting rights or potential voting rights of the entity. These entities are consolidated.

Entities are consolidated on the basis of the single-entity financial statements of ETH Zurich and the controlled entities. Receivables, liabilities, revenue and expenses from transactions between the consolidated entities as well as ownership interests and unrealised intra-economic entity surpluses are eliminated on consolidation. All financial statements are prepared in accordance with uniform policies and normally as at the same reporting date. Due to time constraints, it is sometimes necessary to use prior-year financial statements for controlled entities rather than the financial statements as at 31 December of the reporting period. The prior-year financial statements used make up an insignificant portion of the consolidated financial statements of ETH Zurich and are adjusted for significant transactions between the prior-year reporting date and 31 December of the reporting period.

Investments in entities 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.

Associated entities are entities where ETH Zurich has significant influence, but not control. ETH Zurich normally has significant influence over an associated entity if it holds a 20 to 50 percent share of the voting rights. These investments are not consolidated, but are instead accounted for using the equity method and recognised as investments in associated entities. Under the equity method, the carrying amount of an investment is its cost, which is subsequently adjusted to reflect any changes in the associated entity's net assets (in proportion to ETH Zurich's share in the associated entity).

An overview of the controlled and associated entities can be found in note 29.

Currency translation

Transactions in a currency other than the functional currency are translated using the exchange rate at the transaction date.

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

Assets and liabilities of controlled entities with a different functional currency are translated at the closing rate, and the statement of financial performance and cash flow statement at 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	
	31.12.2018	31.12.2017	2018	2017
Currency				
1 EUR	1.1265	1.1701	1.1549	1.1116
1 USD	0.9855	0.9743	0.9780	0.9846
1 SGD	0.7205	0.7289	0.7250	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 based on the resources consumed. 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 accounted for on an accrual basis when the goods are delivered or the services rendered.

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.

Donations and bequests

Revenue from donations and bequests is classified as a non-exchange transaction (IPSAS 23). Such 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 as assets in accordance with the applicable provisions when the agreement is signed.

- Donated rights to use assets in the sense of an operating lease are recognised as revenue and expense. Donated rights to use assets 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, it is stated as a liability 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.

- Services in-kind received are not recognised, but are instead disclosed and commented upon in the notes if they are material.

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 accounted for on an accrual basis when the goods are delivered or the services rendered.

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 an initial or remaining term of up to 90 days at the acquisition date. 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 on 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 are stated at cost.

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 that have future economic benefits or service potential over several years and can be measured reliably are recognised as assets and depreciated over the estimated useful life.

The residual value of property, plant and equipment that is scrapped 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 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. A leased asset is depreciated over its useful life or, if it is not reasonably certain that ownership will transfer at the end of the lease term, over the shorter contract term.

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

Co-financing is third-party funding acquired by ETH Zurich that is used to finance construction projects in property owned by the Federal Government. Co-financing is measured based on the valuation of the underlying property, which the Federal Government recognises at cost less accumulated depreciation. A property's ongoing depreciation reduces the value of the co-financing to the same degree as the underlying property.

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
The net defined benefit liabilities presented in the balance sheet are measured in accordance with the methods under IPSAS 39. They correspond to the present value of the defined benefit obligations (DBO) less the fair value of the plan assets. The description of the pension scheme and the beneficiaries at ETH Zurich can be found in note 22.

The defined benefit obligations and service cost are determined annually by external experts using the projected unit credit (PUC) method. The calculation is made based on information about the beneficiaries (salary, vested benefits, etc.) and using both demographic variables (retirement rates, disability rates, mortality rates, etc.) and financial variables (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.

The defined benefit obligations were measured based on the current membership base of the ETH Domain's pension scheme as of 31 October 2018, using actuarial assumptions as of 31 December 2018 (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 2018. The fair value of the plan assets was used, including estimated performance as of 31 December 2018.

Current service cost, past service cost resulting from plan amendments, 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 settlements 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.

Dedicated third-party funds
Liabilities from dedicated projects that arise from non-exchange transactions (IPSAS 23) are presented in the balance sheet as dedicated third-party funds. They are allocated solely to non-current liabilities because the projects usually last for several years and the current portion of the liability cannot be determined in most cases due to the nature of the projects.

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 (recognition in equity)
- 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.

- Revaluation reserves for net defined benefit liabilities: 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
- 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 been recognised to cover them. They comprise reserves for teaching and research projects as well as "election commitments", i.e. funds granted to newly elected professors under contractual arrangements for the purpose of setting up their professorship.

- 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
Unused funds for which there are no contractual or internal provisions in accordance with IPSASs are presented as free reserves. They are not restricted in terms of time or purpose.

Reserves from associated entities
This item comprises reserves from the inclusion of the share of equity of investments in associated entities that are accounted for using the equity method. These dedicated reserves cannot be accessed directly.

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 increases/decreases in the reserves 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 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.

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 depends on estimates and assumptions involved in applying the accounting policies, where management may exercise a certain degree of judgement. 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 high degree of estimation 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, liabilities and provisions. They are based on a risk-free rate and a premium for credit risk.

Management judgements in the application of accounting policies
There were no particular or exceptional management judgements in the application of accounting policies that had a material effect on the annual consolidated financial statements in the reporting period or in the previous year.

Notes

1 Total federal contribution

The total federal contribution amounted to CHF 1,326 million in the reporting period (previous year: CHF 1,367 million). It comprises the federal financial contribution (in the narrower sense) or expenditure credit, which is used to cover basic teaching and research equipment, and the federal contribution to accommodation to cover rent charged by the Federal Government for the use of the buildings it owns. 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).

The financial contribution declined by CHF 24 million, or 2 percent, to CHF 1,177 million in 2018. The contribution to accommodation fell by CHF 16 million to CHF 149 million. This was due mainly to a decline in the proportion of buildings calculated to be in use by ETH Zurich within the ETH Domain despite an increase in the space required.

2 Tuition fees and other utilisation fees

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

Revenue from tuition fees and utilisation fees was unchanged year on year at CHF 24 million.

3 Research contributions, mandates and scientific services

CHF million	2018	of which revenues (IPSAS 23)	of which revenues (IPSAS 9)	2017	Change absolute
Swiss National Science Foundation (SNSF)	124	124	0	132	– 8
Swiss Innovation Agency (Innosuisse)	22	22	0	23	– 1
Special federal funding of applied research	26	12	14	23	3
EU Framework Programmes for Research and Innovation (FP)	64	64	0	64	0
Industry-oriented research (private sector)	60	19	40	49	11
Other project-oriented third-party funding (incl. cantons, municipalities, international organisations)	42	29	13	35	6
Total research contributions, mandates and scientific services	**337**	**270**	**67**	**326**	**11**

Revenue from research contributions, mandates and scientific services mostly increased: Industry-oriented research showed a rise in revenue (CHF +11 million) that was partly related to projects reaching a more advanced stage of completion and increased project volumes. A further portion of the rise resulted from the fact that scientific services provided to third parties have since 2018 been presented as revenue from industry-oriented research more consistently than was the case in previous years (see also note 5). Revenue from other project-oriented third-party funding was also higher than in the previous year (CHF +6 million), with around half of the increase in revenue attributable to an entity controlled by ETH Zurich and included in the annual consolidated financial statements. Revenue from federal research mandates rose by CHF 3 million due primarily to the progress on ongoing projects.

Research contributions from EU Framework Programmes for Research and Innovation held steady at CHF 64 million, of which CHF 13 million comprised federal contributions granted directly from federal funds as part of the bridge financing (Horizon 2020) (previous year: CHF 17 million).

SNSF revenue declined (CHF – 8 million) due to new projects in the initial phase. The conclusion of the SystemsX.ch research initiative and the Nano-Tera.ch collaboration project also contributed to the decline in revenue, as no new tenders took place. Innosuisse revenue was moderately lower (CHF – 1 million), reflecting factors such as the smaller volume of new projects.

Information on receivables from non-exchange transactions, 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

Revenue from donations and bequests amounted to CHF 136 million (CHF +54 million). It resulted mostly from donation agreements signed in 2018. Such agreements are usually recognised in surplus or deficit in full in the year of signing and are mostly subject to certain conditions.

5 Other revenue

CHF million	2018	2017	Change absolute
Licences and patents	3	2	0
Sales	6	7	– 1
Refunds	4	4	– 1
Other services	14	20	– 6
Real estate revenue	5	10	– 4
Revenue from real estate owned by the Federal Government left for use	3	0	3
Profit from disposals (property, plant and equipment)	1	0	0
Other miscellaneous revenue	9	8	1
Total other revenue	**44**	**51**	**– 7**

The reporting period was the first in which revenue from real estate owned by the Federal Government left for use was presented separately (previous year: component of real estate revenue). In 2018, half of this revenue was for the first time recognised on an accrual basis within other operating expenses as a levy remitted to the Federal Government (note 7). In addition, scientific services provided to third parties have since 2018 been presented as revenue from industry-oriented research more consistently than was the case in previous years (note 3).

6 Personnel expenses

CHF million	2018	2017	Change absolute
Professors	127	125	2
Scientific personnel	453	448	5
Technical and administrative personnel, apprentices, trainees	335	318	17
IC, Suva and other refunds	– 5	– 4	0
Total salaries and wages	**910**	**886**	**24**
Social insurances OASI / DI / IC / MB	58	56	1
Net pension costs	147	148	– 1
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**	**218**	**1**
Other employer contributions	0	– 1	1
Temporary personnel	0	0	0
Change in provisions for untaken leave and overtime	4	5	– 1
Change in provisions for contributions to long-service awards	– 6	0	– 6
Other personnel expenses	6	6	0
Total personnel expenses	**1,133**	**1,115**	**18**

Salaries and wages increased by CHF 24 million, or 3 percent, year on year. This was related to the rise in average full-time equivalents by 247 FTEs to 9,528 FTEs (+3 percent). Of this, CHF 4 million, or 34 FTEs, concerned one of the entities controlled by ETH Zurich. Details on the changes in personnel can be found in the Human resources and infrastructure section (starting on page 54).

Net pension costs represent the net defined benefit liability accrued and allocated on a straight-line basis over the years of service.

The change in provisions for contributions to long-service awards (CHF –6 million) was attributable to actuarial gains resulting from the change in the method of calculation.

7 Other operating expenses

CHF million	2018	2017	Change absolute
Expenses for goods and materials	66	61	6
Premises costs	236	242	– 6
Other operating costs	234	212	22
Total other operating expenses	**536**	**515**	**21**

Expenses for goods and materials increased (CHF +6 million) due primarily to higher expenses for biological preparations and chemicals, semi-finished and finished products, and material goods not recognised as assets.

Premises costs declined (CHF – 6 million), reflecting lower accommodation expense for the use of property owned by the Federal Government. At CHF 149 million, this represented the largest item within premises costs (CHF – 16 million; see note 1). Conversely, expenses for user-specific improvements and operating equipment, expenditure on property leased externally and incidental premises costs rose.

The increase in other operating costs (CHF +22 million) related primarily to higher expenses for advisory services, IT and telecommunications, library expenses, public relations work, publication expenses and the first-time levy remitted to the Federal Government for Federal Government-owned real estate left for use (see also note 5).

8 Transfer expenses

CHF million	2018	2017	Change absolute
Scholarships and grants to students and doctoral students	13	14	0
Contributions to research projects	3	3	0
Other transfer expenses	6	4	2
Total transfer expenses	**23**	**21**	**2**

9 Net finance income/expense

CHF million	2018	2017	Change absolute
Finance income			
Interest income	6	4	2
Income from investments	3	3	0
Changes in fair value of financial assets	1	17	– 16
Foreign currency gains	2	3	– 1
Other finance income	0	0	0
Total finance income	**12**	**27**	**– 16**
Finance expense			
Interest expense	1	1	0
Other financing costs for provision of capital	0	0	0
Changes in fair value of financial assets	16	2	14
Foreign currency losses	3	3	0
Impairment of loans and fixed deposits	0	0	0
Other finance expense	1	1	0
Total finance expense	**20**	**7**	**14**
Total net finance income / expense	**– 9**	**21**	**– 29**

Net finance expense was the result of the negative performance of the asset management mandates (see also note 16), which is reflected in Changes in fair value of financial assets on both the income and the expense side.

Interest income resulted mostly from unwinding of the discount on material receivables. As the balance of these receivables rose year on year, the interest income on them increased (CHF 4 million versus CHF 2 million in the previous year).

Interest expense primarily contained 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	31.12.2018	31.12.2017	Change absolute
Cash	1	1	0
Swiss Post	58	55	3
Bank	24	21	4
Short-term deposits (<90 days)	100	115	– 15
Total cash and cash equivalents	**183**	**192**	**– 9**

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 an initial or remaining term of up to 90 days at the acquisition date). 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.

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

11 Receivables

CHF million	31.12.2018	31.12.2017	Change absolute
Receivables from project contracts and donations	867	734	133
Other receivables	1	1	0
Value adjustments	0	0	0
Total receivables from non-exchange transactions	**867**	**734**	**133**
of which current	241	243	– 2
of which non-current	627	492	135
Trade accounts receivable	18	15	3
Other receivables	0	0	0
Value adjustments	– 1	– 1	0
Total receivables from exchange transactions	**18**	**14**	**3**
of which short-term	18	14	3
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.

Receivables from donations saw the sharpest rise. Receivables for EU and SNSF projects also increased, as did receivables for private-sector and applied research projects. Conversely, receivables for Innosuisse projects and for projects financed out of other third-party funds decreased.

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
31.12.2018					
Gross amount	**886**	**876**	**8**	**1**	**1**
Receivables from non-exchange transactions	867	863	4	0	1
Receivables from exchange transactions	18	13	5	0	0
Value adjustments	**– 1**	**– 1**	**0**	**0**	**0**
of which individually impaired	0	0	0	0	0
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 on receivables were small in amount (unchanged at CHF – 1 million) and related to receivables from exchange transactions.

12 Inventories

Inventories comprise purchased inventories (there are no self-produced inventories). They stood at CHF 5 million (previous year: CHF 6 million).

13 Prepaid expenses and accrued income

CHF million	31.12.2018	31.12.2017	Change absolute
Interest	0	0	0
Prepaid expenses	25	23	3
Other prepaid expenses and accrued income	2	1	0
Total prepaid expenses and accrued income	**27**	**24**	**3**

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

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]
31.12.2018				
Reporting date used	**31.12.2018**	**31.12.2017**	**31.12.2017**	**31.12.2017**
Current assets	264	4	1	8
Non-current assets	226	107	53	5
Short-term liabilities	0	0	5	0
Long-term liabilities	2	54	33	3
Revenue	131	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 (–)	– 12	2	1	0
Dividends received from the associated entity	0	0	0	0
31.12.2017				
Reporting date used	**31.12.2017**	**31.12.2016**	**31.12.2016**	**31.12.2016**
Current assets	254	2	2	8
Non-current assets	171	108	55	5
Short-term liabilities	1	0	8	0
Long-term liabilities	1	55	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.

Investments in associated entities presented in the balance sheet declined from CHF 104 million to CHF 93 million, in particular reflecting the share of losses in the reporting period (CHF – 11 million).

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	Information and communication	Advance payments, movable assets under construction	**Total movable assets**	Property, buildings [1]	Assets under construction	**Total immovable assets**	**Total property, plant and equipment**	**Total intangible assets [2]**
2018									
Purchase value									
As of 1.1.2018	**841**	**231**	**16**	**1,088**	**281**	**44**	**326**	**1,414**	**9**
Additions	53	18	3	74	0	25	25	**99**	**3**
Reclassifications	8	0	– 8	0	7	– 7	0	**0**	**0**
Disposals	– 45	– 19	0	– 63	– 18	0	– 18	**– 81**	**– 1**
As of 31.12.2018	**857**	**231**	**12**	**1,099**	**271**	**62**	**333**	**1,433**	**11**
Accumulated depreciation									
As of 1.1.2018	**713**	**172**	**0**	**885**	**82**	**0**	**82**	**968**	**6**
Depreciation	48	30	0	79	23	0	23	**102**	**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	– 44	– 19	0	– 63	– 15	0	– 15	**– 78**	**– 1**
As of 31.12.2018	**718**	**183**	**0**	**901**	**91**	**0**	**91**	**992**	**6**
Balance sheet value as of 31.12.2018	**139**	**47**	**12**	**198**	**180**	**62**	**243**	**441**	**5**
thereof leased assets					15		15	15	
2017									
Purchase value									
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									
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	

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

Movable items of property, plant and equipment consist largely of technical/scientific equipment and information and communications technology (ICT) equipment.

ETH Zurich's immovable property, plant and equipment consists of five properties (CHF 18 million), one property under a finance lease (CHF 15 million) and leasehold improvements (CHF 147 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	31.12.2018	31.12.2017	Change absolute
Securities and fixed deposits	182	192	–10
Positive replacement values	0	0	0
Other financial assets	829	799	30
Loans	0	0	0
Total current financial assets and loans	**1,011**	**991**	**20**
Securities and fixed deposits	0	0	0
Other financial assets	3	3	0
Loans	1	0	1
Total non-current financial assets and loans	**4**	**3**	**1**

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 an initial or remaining term of three to twelve months at the acquisition date were increased to CHF 795 million in 2018 (previous year: CHF 765 million), leading to a rise in other current financial assets. Conversely, current securities and fixed deposits declined due to the performance of the asset management mandates.

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 2018.

17 Co-financing

CHF million	2018	2017	Change absolute
Purchase value			
As of 1.1.	**62**	**62**	**0**
Additions	0	0	0
Disposals	0	0	0
As of 31.12.	**62**	**62**	**0**
Accumulated depreciation			
As of 1.1.	**12**	**10**	**2**
Depreciation	2	2	0
Disposals	0	0	0
As of 31.12.	**14**	**12**	**2**
Balance sheet value as of 31.12.	**48**	**50**	**– 2**

18 Current liabilities

CHF million	31.12.2018	31.12.2017	Change absolute
Trade payables	0	25	– 25
Liabilities to social insurance institutions	15	15	0
Other current liabilities	45	41	4
Total current liabilities	**60**	**81**	**– 21**

With regard to an SAP system migration as of 1 January 2019, all trade payables were paid as of the end of 2018, as a result of which the balance showed a marked decrease year on year.

19 Financial liabilities

Current and non-current financial liabilities

As in the previous year, non-current financial liabilities amounted to CHF 19 million and consisted primarily of liabilities under the finance lease (CHF 16 million).

Current financial liabilities were small in amount and unchanged year on year at the end of 2018.

Finance lease disclosures

CHF million	Future minimum leasing payments 2018	Future financial expenses 2018	Present value of future minimum leasing payments 2018
Due dates			
Due within 1 year	1	1	0
Due within 1 to 5 years	6	5	1
Due after more than 5 years	30	15	15
Total as of 31.12.	**37**	**21**	**16**

	2018
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	31.12.2018	31.12.2017	Change absolute
Interest	0	0	0
Deferred income	53	52	1
Other accrued expenses and deferred income	23	24	– 1
Total accrued expenses and deferred income	**75**	**76**	**0**

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

21 Provisions

CHF million	Provisions for untaken leave and overtime	Other long-term employee benefits (IPSAS 39)	Other provisions	**Total provisions**
2018				
As of 1.1.2018	44	34	0	78
Creation (incl. increase)	4	0	1	5
Reversal	0	– 2	0	– 2
Appropriation	0	– 3	0	– 3
Increase in present value	0	0	0	0
As of 31.12.2018	**48**	**28**	**1**	**77**
of which short-term	48		1	49
of which long-term		28		28
2017				
As of 1.1.2017	39	34	0	72
Creation (incl. increase)	5	5	0	10
Reversal	0	0	0	0
Appropriation	0	– 5	0	– 5
Increase in present value	0	0	0	0
As of 31.12.2017	**44**	**34**	**0**	**78**
of which short-term	44		0	44
of which long-term		34		34

Provisions for untaken leave and overtime increased by CHF 4 million year on year to CHF 48 million. Provisions for other long-term employee benefits in accordance with IPSAS 39 decreased (CHF – 6 million) as a result of actuarial gains related to a change in the method used to calculate future long-service awards.

In the reporting period, a provision was recognised for an insured event. There were no further provisions for dismantling, litigation, guarantees, warranties or other items in the reporting period or in the previous year.

22 Net defined benefit liabilities

Most 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.

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 spread 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 101.8 percent at the end of the year (2017: 108.0 percent, definitive). The provisional economic funding ratio for the ETH Domain's pension scheme at PUBLICA was 84.7 percent at the end of the year (2017: 89.5 percent, definitive).

Special events
Due to the low interest rate environment that has persisted on the capital markets for some years now, the PUBLICA Board of Directors decided on 25 January 2018 to reduce the technical interest rate with effect from 1 January 2019. Since 1 January 2015, the discount rate for the ETH Domain pension scheme had been 2.75 percent. With effect from 1 January 2019, it was set at 2.0 percent. As a result, the conversion rate also had to be adjusted. Until the end of 2018, this was 5.65 percent at the age of 65; as of 1 January 2019, it was set at 5.09 percent. The Board of Directors decided on a range of mitigation measures for the generation who were between 60 and 65 years of age at the date of the switch. Beneficiaries aged 65 will therefore be fully compensated and beneficiaries aged 60 and above at least partially compensated for the change. These measures apply only when drawing a pension and taking a lump-sum payment.

The governing body of the ETH Domain pension scheme made up of equal numbers of representatives decided to initiate further mitigation measures. Savings contributions will be increased and the prudent provisioning policy will allow additional increases in retirement savings as of 1 January 2019.

The Federal Council approved the changes on 25 April 2018. The plan amendments were therefore measured at a discount factor of 0.5 percent (as of 30 April 2018) and were included in the IPSAS measurement as past service cost.

Net defined benefit liabilities

CHF million	31.12.2018	31.12.2017	Change absolute
Present value of defined benefit obligations	– 4,318	– 4,265	– 53
Fair value of plan assets	3,262	3,372	– 111
Recognised net defined benefit liabilities	**– 1,056**	**– 893**	**– 164**

The increase in net defined benefit liabilities was primarily attributable to the decline in plan assets as a result of the negative performance from the plan assets and the increase in the membership base.

Net pension costs

CHF million	2018	2017	Change absolute
Current service cost (employer)	142	146	– 4
Past service cost	5	2	3
Gains (–) / losses (+) from plan settlements	0	0	0
Interest expense from defined benefit obligations	13	9	4
Interest income from plan assets	– 10	– 6	– 4
Administrative costs (excl. asset management costs)	2	2	0
Other	0	0	0
Total net pension costs incl. interest expense recognised in statement of financial performance	**151**	**152**	**– 1**

Net pension costs changed minimally year on year (CHF – 1 million): The decrease in current service cost was the result of the changes in actuarial assumptions in the previous year. Past service cost included the contributions for professors and the effects of the change in the technical interest rate and the conversion rate at PUBLICA. The changes in interest income and expense on defined benefit obligations were attributable to the higher discount rate as of 1 January (0.3 percent in 2018 versus 0.2 percent in 2017).

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 105.6 million and employee contributions of CHF 56.4 million are expected for the coming financial year.

Revaluation recognised in equity

CHF million	31.12.2018	31.12.2017	Change absolute
Actuarial gains (–) / losses (+)	8	– 58	66
from change in financial assumptions	– 19	– 151	132
from change in demographic assumptions	– 18	0	– 18
from experience adjustments	45	93	– 48
Return on plan assets (excl. interest income), (gains [–] / losses [+])	115	– 232	347
Other	0	0	0
Revaluation recognised in equity	**123**	**– 290**	**413**
Cumulative amount of revaluation recognised in equity (gain [–] / loss [+])	**652**	**529**	**123**

An actuarial loss of CHF 8 million was recognised in equity in the reporting period (2017: gain of CHF 58 million). Set against actuarial losses from experience adjustments were gains from the change in financial and demographic assumptions. These resulted, respectively, from the reduced return on retirement savings and the change in probabilities of disability from 100 % to 85 % under the BVG 2015 actuarial tables. The net actuarial loss and the negative return on plan assets (CHF 115 million) resulted in a total cumulative loss of CHF 652 million as of 31 December 2018 (2017: CHF 529 million).

Change in the present value of defined benefit obligations

CHF million	2018	2017	Change absolute
Present value of defined benefit obligations as of 1.1.	**4,265**	**4,272**	**– 7**
Current service cost (employer)	142	146	– 4
Interest expense from defined benefit obligations	13	9	4
Employee contributions	56	54	2
Benefits paid in (+) and paid out (–)	– 170	– 160	– 10
Past service cost	5	2	3
Gains (–) / losses (+) from plan settlements	0	0	0
Actuarial gains (–) / losses (+)	8	– 58	66
Other	0	0	0
Present value of defined benefit obligations as of 31.12.	**4,318**	**4,265**	**53**

The weighted average duration of the defined benefit obligations was 14.7 years as of 31 December 2018 (previous year: 15.0 years).

Change in the fair value of plan assets

CHF million	2018	2017	Change absolute
Fair value of plan assets as of 1.1.	**3,372**	**3,134**	**238**
Interest income from plan assets	10	6	4
Employer contributions	111	108	3
Employee contributions	56	54	2
Benefits paid in (+) and paid out (–)	– 170	– 160	– 10
Gains (+) / losses (–) from plan settlements	0	0	0
Administrative costs (excl. asset management costs)	– 2	– 2	0
Return on plan assets (excl. interest income), (gains [+] / losses [–])	– 115	232	– 347
Other	0	0	0
Fair value of plan assets as of 31.12.	**3,262**	**3,372**	**– 111**

Reconciliation of net defined benefit liabilities

CHF million	2018	2017	Change absolute
Net defined benefit liabilities as of 1.1.	**– 893**	**– 1,137**	**245**
Net pension costs incl. interest expense recognised in statement of financial performance	– 151	– 152	1
Revaluation recognised in equity	– 123	290	– 413
Employer contributions	111	108	3
Obligations paid directly by the entity	0	0	0
Other	0	0	0
Net defined benefit liabilities as of 31.12.	**– 1,056**	**– 893**	**– 164**

Major categories of plan assets

In %	31.12.2018	Listed	Not listed	31.12.2017	Listed	Not listed
Liquidity	2	3	0	3	4	0
Bonds (in CHF) Confederation	6	7	0	6	6	0
Bonds (in CHF) excl. Confederation	12	13	0	11	12	0
Government bonds (in foreign currencies)	26	28	0	26	28	0
Corporate bonds (in foreign currencies)	14	15	0	14	15	0
Mortgages	0	0	0	0	0	0
Shares	28	31	0	31	33	0
Real estate	7	1	65	5	0	71
Commodities	2	2	0	2	2	0
Other	3	0	35	2	0	29
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 %	2018	2017	Change absolute
Discount rate as of 1.1.	0.30	0.20	0.10
Discount rate as of 31.12.	0.30	0.30	0.00
Expected salary development	0.50	0.50	0.00
Expected pension development	0.00	0.00	0.00
Interest on retirement savings	0.30	0.50	– 0.20
Life expectancy at age 65 – women (no. of years)	24.54	24.43	0.11
Life expectancy at age 65 – men (no. of years)	22.50	22.38	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 2018	Decrease in assumption 2018	Increase in assumption 2017	Decrease in assumption 2017
Discount rate (change +/– 0.25 %)	– 153	164	– 154	165
Expected salary development (change +/– 0.25 %)	16	– 16	17	– 17
Expected pension development (change +/– 0.25 %)	127	– 120	127	– 121
Interest on retirement savings (change +/– 0.25 %)	26	– 25	26	– 26
Life expectancy (change +/–1 year)	151	– 153	151	– 153

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 return on retirement savings and assumptions about salary and pension trends were increased or reduced by fixed percentage points. The sensitivity to life expectancy was calculated by reducing or increasing life expectancy 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	31.12.2018	31.12.2017	Change absolute
Swiss National Science Foundation (SNSF)	276	249	27
Swiss Innovation Agency (Innosuisse)	36	48	– 13
EU Framework Programmes for Research and Innovation (FP)	209	167	42
Special federal funding of applied research	28	26	1
Industry-oriented research (private sector)	38	36	2
Other project-oriented third-party funding	29	31	– 2
Donations and bequests	111	105	6
Total dedicated third-party funds	**726**	**663**	**63**

Due to the growth in project volumes, the sharpest rise in dedicated third-party funds was recorded on EU projects (CHF +42 million), above all Future and Emerging Technologies (FET) projects and ERC grants towards year-end. SNSF projects likewise saw a rise (CHF +27 million) attributable to new projects. The increase in dedicated third-party funds classified as donations and bequests (CHF +6 million) related in particular to an inheritance.

Dedicated third-party funds for Innosuisse projects were on a downward trajectory (CHF – 13 million). The reduction related to the stage of completion of existing projects and the initiation of a smaller number of new projects compared with the previous year.

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 64).

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 64).

Credit and default risk

Maximum exposure to credit risk, breakdown by counterparty

CHF million	**Total**	Federal Government	European Commission FP[1]	SNSF, Innosuisse, OASI social service, Suva	SNB and banks with government guarantee	PostFinance and other banks	Other counter-parties
31.12.2018							
Cash and cash equivalents	183	101	0	0	15	66	0
Receivables from non-exchange transactions	867	41	176	231	0	0	420
Receivables from exchange trans-actions	18	7	0	0	0	0	11
Financial assets and loans	1,015	795	0	0	0	9	211
Prepaid expenses and accrued income	2	0	0	0	0	0	2
Total	**2,085**	**943**	**176**	**231**	**15**	**76**	**643**
Total prior period	**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. These include systematic liquidity planning, monitoring and optimisation as well as 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
31.12.2018					
Non-derivative financial liabilities					
Current liabilities	60	60	60	0	0
Leasing liabilities	16	37	1	6	30
Financial liabilities	3	3	0	0	3
Accrued expenses and deferred income	23	23	23	0	0
Derivative financial liabilities	**0**	**0**	**0**	**0**	**0**
Total	**102**	**123**	**84**	**6**	**33**
Total prior period	**124**	**144**	**106**	**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. Liquidity risk is low.

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 9 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 10-percent decrease in price would reduce surplus or deficit by CHF 13 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.

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
31.12.2018					
Net currency balance	**1,793**	**1,765**	**9**	**5**	**15**
Sensitivity affecting financial performance +/– 10%			1	0	2
Closing rate			1.1265	0.9855	
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 the EUR and USD categories related primarily to receivables from exchange transactions. The net currency balance for other currencies was unchanged at CHF 15 million and related primarily to asset management mandates and the entity in Singapore controlled and consolidated by ETH Zurich.

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 fair value of non-current receivables from non-exchange transactions and non-current loans is calculated based on the payments falling due in the future, which are discounted at market interest rates.

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 at 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
31.12.2018						
Cash and cash equivalents	183	183	183			
Receivables from non-exchange transactions	867	867	867			
Receivables from exchange transactions	18	18	18			
Financial assets and loans	1,015	1,015	796	216	3	
Prepaid expenses and accrued income	2	2	2			
Financial liabilities [1]	102	102		0		102
31.12.2017						
Financial assets (in a broader sense) [2]	1,936	1,936	1,707	226	3	
Financial liabilities [1]	124	124		0		124

1. Current liabilities, finance lease liabilities, other financial liabilities, other accrued expenses and deferred income.
2. Cash and cash equivalents, receivables from non-exchange transactions, receivables from exchange transactions, financial assets and loans, other prepaid expenses and accrued income.

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
31.12.2018				
Financial assets	219	216	0	3
Financial liabilities	0	0	0	0
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
2018				
Interest income (+) / interest expense (–)	4	2		– 1
Income from investments		3	0	
Change of fair value		– 14		
Currency translation differences, net	0	0		0
Impairments	0		0	
Reversal of impairment	0			
Gains and losses reclassified from equity to the statement of financial performance			0	
Net surplus or deficit recorded in the statement of financial performance	**4**	**– 10**	**0**	**– 1**
Net surplus or deficit recognised in equity			**0**	
Total net surplus or deficit by category	**4**	**– 10**	**0**	**– 1**
2017				
Total net surplus or deficit by category	**3**	**19**	**1**	**– 1**

Fair value changes (CHF – 14 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 CHF 0.2 million at the end of 2018 (previous year: CHF 3 million).

Contingent assets

Quantifiable contingent assets amounted to around CHF 2 million at the end of 2018 (previous year: CHF 0.1 million) and resulted mostly from ongoing bankruptcy proceedings and compensation claims.

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 could not be quantified reliably in the reporting period. These comprise 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	31.12.2018	31.12.2017	Change absolute
Financial commitments up to 1 year	4	7	– 3
Financial commitments from 1 to 5 years	0	0	0
Financial commitments > 5 years	0	0	0
Total financial commitments	**4**	**7**	**– 3**

At the end of 2018, there were financial commitments relating to the purchase of technical / scientific equipment amounting to CHF 4 million.

27 Operating leases

CHF million	2018	2017	Change absolute
Due dates			
Due within 1 year	22	23	– 1
Due within 1 to 5 years	56	64	– 8
Due after more than 5 years	49	76	– 27
Future minimum payments for non-cancellable operating lease as of 31.12.	**127**	**164**	**– 36**
Leasing expenses			
Minimum lease payments	23	23	1
Conditional lease payments	0	0	0
Payments from subleasing	1	1	0
Leasing payments of current period	**25**	**24**	**1**
Additional details			
Future revenue from sublease (from non-cancellable contracts)	1	1	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 69).

29 Relationships with controlled and associated entities

Controlled entities

The entities listed below were consolidated.

	Legal form	Nature of collaboration / business activity	Domicile	Currency	Jurisdiction	Proportion of voting rights and participating share (in %) [2]		Reporting date used
						31.12.2018		
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	31.03.2018
Rübel Geobotanical Research Institute Foundation[1]	Foundation	Promoting geobotanical science (plant sociology, plant ecology, plant distribution, vegetation history).	Zurich	CHF	Switzerland	57	100	31.12.2017

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.
2. As in the previous year.

Summarised financial information on the two controlled entities is set out in the table below:

CHF million	31.12.2018	of which ETH Singapore SEC Ltd.	of which Rübel Geobotanical Research Institute Foundation	31.12.2017
Current assets	11	7	4	10
Non-current assets	3	1	3	4
Short-term liabilities	0	0	0	1
Long-term liabilities	10	7	3	10
Revenue	16	16	0	12
Surplus (+) or deficit (–)	0	0	0	0

Associated entities

All the associated entities listed were accounted for using the equity method.

	Legal form	Nature of collaboration / business activity	Domicile	Currency	Jurisdiction	Proportion of voting rights and participating share (in %)[2]	
Material associated entities						31.12.2018	
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						31.12.2018	
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.
2. As in the previous year.

Restrictions

At the controlled and associated entities listed above, ETH Zurich does not have any rights of access to the assets. Therefore, it cannot initiate a transfer of liquid funds or otherwise access the entities' funds.

Entities below the thresholds defined in the OFA

The Ordinance on the Finance and Accounting of the ETH Domain (OFA) 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:

	31.12.2018	31.12.2017
Controlled entities		
Quantity	4	4
Total assets (CHF million)	12	12
Associated entities		
Quantity	5	6
Total assets (CHF million)	14	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 25 February 2019. 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 2018.

EIDGENÖSSISCHE FINANZKONTROLLE
CONTRÔLE FÉDÉRAL DES FINANCES
CONTROLLO FEDERALE DELLE FINANZE
SWISS FEDERAL AUDIT OFFICE

Reg. Nr. 1.19044.934.00120.002

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 2018, the consolidated balance sheet as of 31 December 2018, 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 121) present fairly, in all material respects, the consolidated financial position of the ETH Zurich as of December 31, 2018, 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 the requirements of the audit profession 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, 25 February 2019 SWISS FEDERAL AUDIT OFFICE

Regula Durrer
Licensed audit expert

Patrik Lüthi
Licensed audit expert

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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's status in science and business 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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www.ethz-foundation.ch/en/

DONATIONS TO MARK SPECIAL OCCASIONS

A unique birthday gift

The last guests have bid their farewell, their empty glasses on the table. They came to celebrate the 80th birthday of Dieter Seebach, who served as Professor in the ETH Zurich Organic Chemistry Laboratory from 1977 to 2003. Seebach received many awards and honours throughout his research career, and chemists know him by name for his role in developing the Corey–Seebach reaction.

Party guests had paid a registration fee in order to ensure sufficient funding for the big event – but in the end, they generated an extra 5,300 Swiss francs after all costs were covered. What should they do with the money? One of Seebach's former doctoral students had an inspiring idea: donate the entire sum in Professor Seebach's name to help fund an ESOP scholarship. Donations to the ETH Foundation's scheme allow the top Master's students to devote themselves entirely to their studies.

Special occasions like retirements, service anniversaries, staff parties and reunions provide the perfect opportunity for commemorative donations. Celebrate the event with a unique gift that supports education and research at ETH Zurich, whether for specific projects or funding new talent – a very special gift that doesn't just spread joy, but knowledge as well.

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