

Master of Science
Biomedical Engineering



Welcome

The Master of Science in Biomedical Engineering at ETH Zurich in Switzerland was created to meet the growing need for interdisciplinary scientists trained to work at the interface between biology, medicine, engineering and physics. ETH, University Hospital of Zurich and Paul Scherrer Institute provide a fertile ground for innovative biomedical engineering research, numerous BioTech spin-offs and several interdisciplinary academic programmes. The MSc Biomedical Engineering programme at ETH Zurich draws its curricula from eight different departments and provides individually tailored training in one of five subdivisions (tracks) within biomedical engineering:

- Bioelectronics
- Bioimaging
- Biomechanics
- Medical Physics
- Molecular Bioengineering



Curriculum Structure

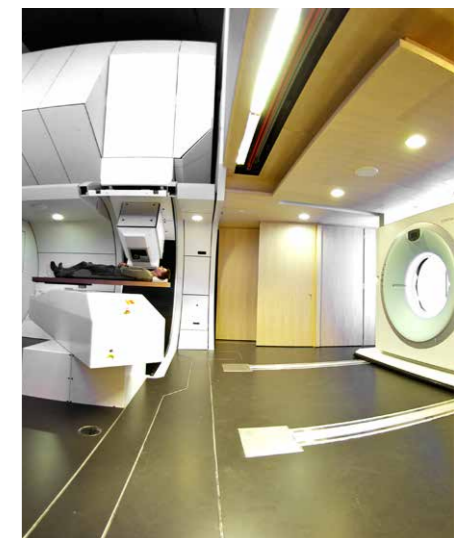
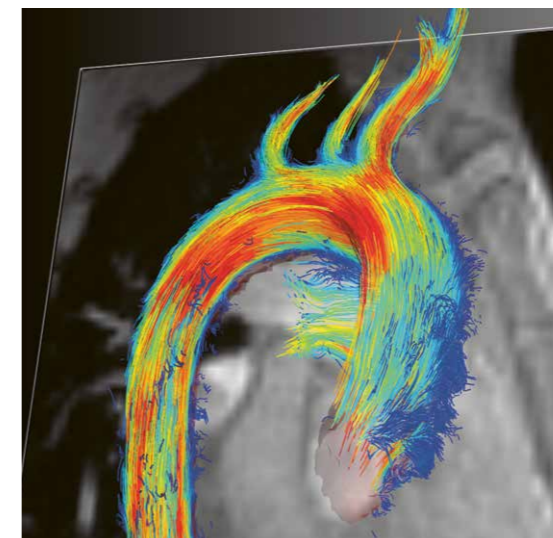
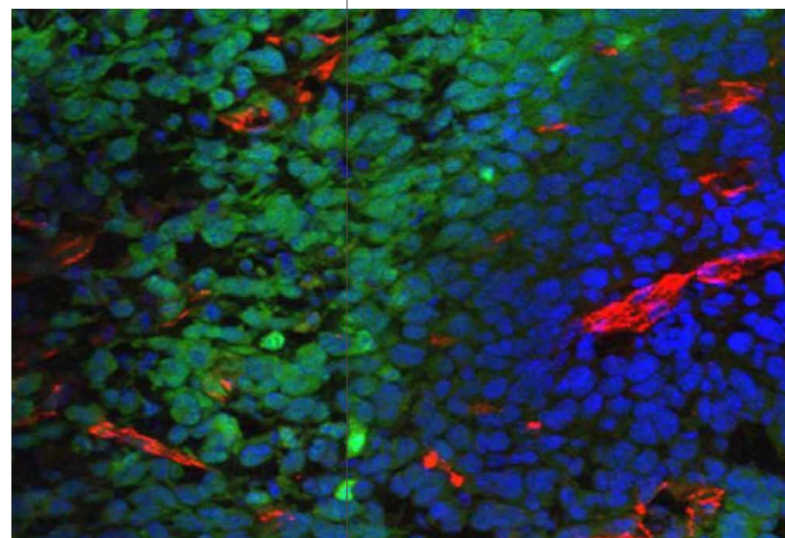
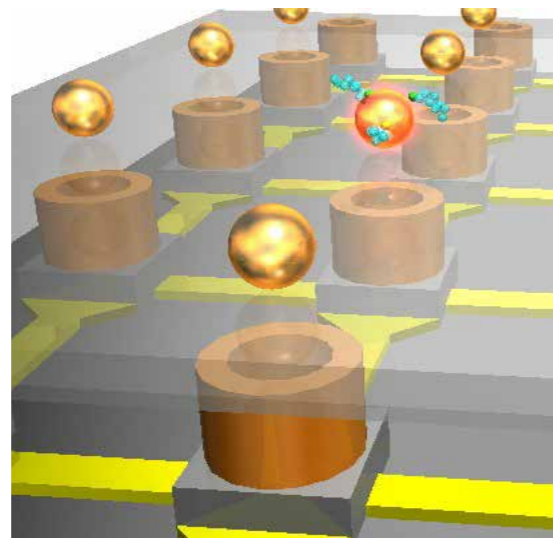
120 credit points are required to obtain a Master of Science ETH in Biomedical Engineering. According to the European Credit Transfer System (ECTS), each credit point corresponds to approximately 25-30 hours of work. Generally, the Master's degree takes 4 to 5 semesters to be completed.

In most instances, the classroom course work is completed in the first two semesters of the programme. The semester project requires a 50% work load and is generally done in the second semester of the programme. The programme typically finishes with a 6-month Master's thesis project. Topics for research projects can be found on the websites of the programme-associated institutes and laboratories (page 12-13).

Track Advisor

The five tracks or specializations within the MSc in Biomedical Engineering are described on pages 7-11. Every track is headed by at least one track advisor, who is an expert in the scientific area and who is available to advise and support you during your studies.

Programme website: www.master-biomed.ethz.ch



Track Courses (52 credit points)

Each track represents an area of specialization within the larger field of biomedical engineering.

1. Track core courses (at least 12 credits)

These courses are at the core of each track.

2. Recommended elective courses

These courses complement and expand the track.

3. Biology courses

For students without prior experience in cell and molecular biology, physiology and anatomy, and who have no training in basic laboratory techniques (e.g. DNA and RNA isolation, protein isolation and identification, cell culture).

Semester Project (12 credit points)

The semester project gives students hands-on research experience in their chosen specialization. The project is supervised by a professor who is associated with one of the four participating departments.

Additional Research Projects and/or Track Courses (24 credit points)

The students can choose among an additional semester project, industry internship, short/long projects, group projects and/or additional track courses.

Science in Perspective (2 credit points)

Courses chosen from the Department of Humanities, Social Sciences and Political Science (D-GESS) which enrich the student's general education.

Master's Thesis (30 credit points)

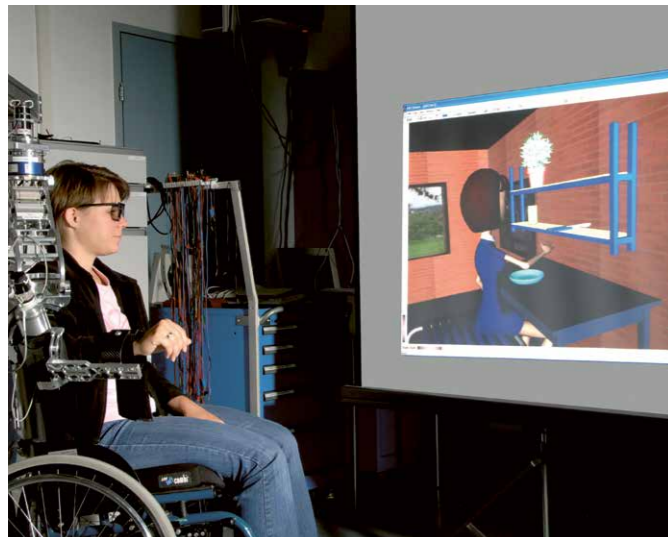
The Master's programme culminates in a 6-month research project which addresses a scientific research question in one's chosen area of specialization. The Master's thesis is guided and supervised by a programme-affiliated faculty member.

Individual Learning Agreement

At the beginning of the first semester, the student will set up an individual learning agreement, in collaboration with the track advisor. This plan selects the track core, elective as well as the biology courses that the student will attend and must pass. All lectures and courses of each specialization are published on the website of the programme, and in the course catalogue of ETH. In addition, students can also suggest other lectures, which have to be approved by the track advisor.

Course catalogue: www.vvz.ethz.ch

The core courses as well as the recommended elective courses are at an introductory or at an advanced level, and cover the chosen area of specialization. The biology courses give introductory lectures to cell- and molecular biology, as well as human anatomy and physiology. In addition, the student will learn in a laboratory course current biological techniques, including mammalian cell culture and in vitro work with RNA, DNA and proteins. The biology courses are only intended for students who do not have prior knowledge in these fields.



Bioelectronics

Track Advisor

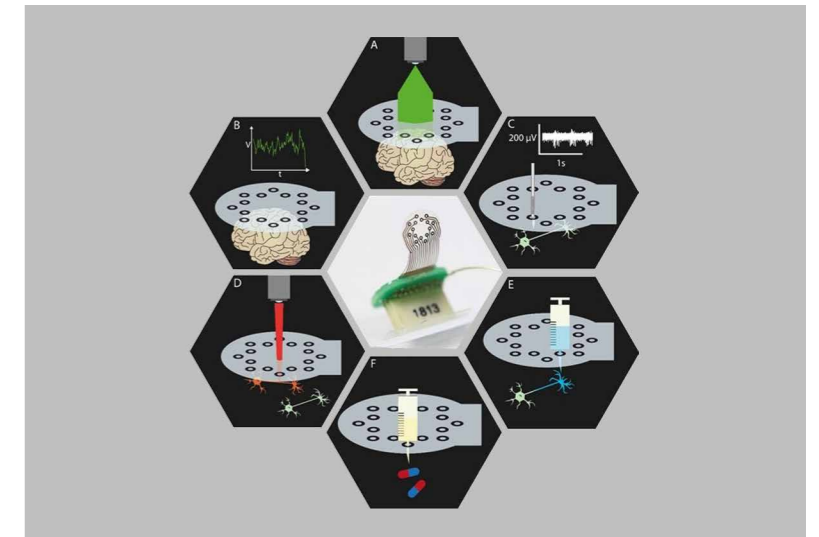
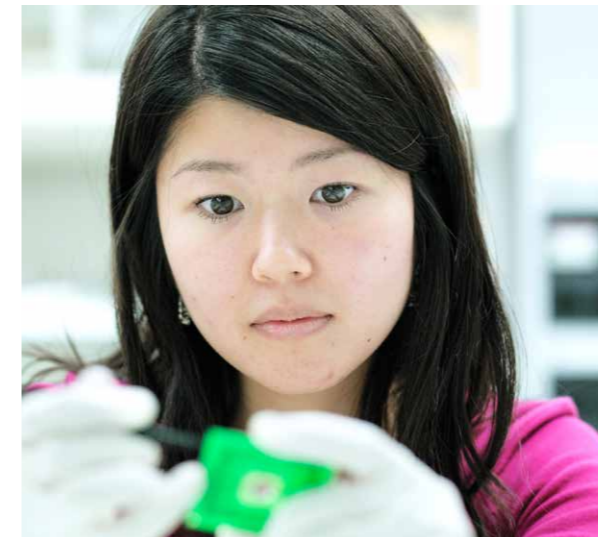
Prof. Janos Vörös
janos.voros@biomed.ee.ethz.ch

This track provides in-depth knowledge for the development of bioelectronic instruments to measure; and signal processing and machine learning tools to analyze and control physical, physiologic or biologic signals in humans and other living organisms. The development of instrumentation is based on technologies including stretchable and wearable electronics, bioMEMS, micro- and nanosystems, biophotonics, sensors, optics and micro-fluidics. These technologies are applied to a wide array of instruments and devices including bioelectronics, hearing aids, biosensors, lab-on-a-chip techniques, and brain-machine interfaces. The course programme can be found at:

www.master-biomed.ethz.ch/education/bioelectronics

Core Courses

- Advanced Signal Analysis, Modeling, and Machine Learning
- Biocompatible Materials
- Biomedical Imaging
- Biomedical Engineering
- Bioelectronics and Biosensors
- Introduction to Neuroinformatics
- Microrobotics
- Microsystems I: Process Technology and Integration
- Nanosystems
- Neuromorphic Engineering II
- Physics in Medical Research: From Atoms to Cells
- Translational Neuromodeling



Bioimaging

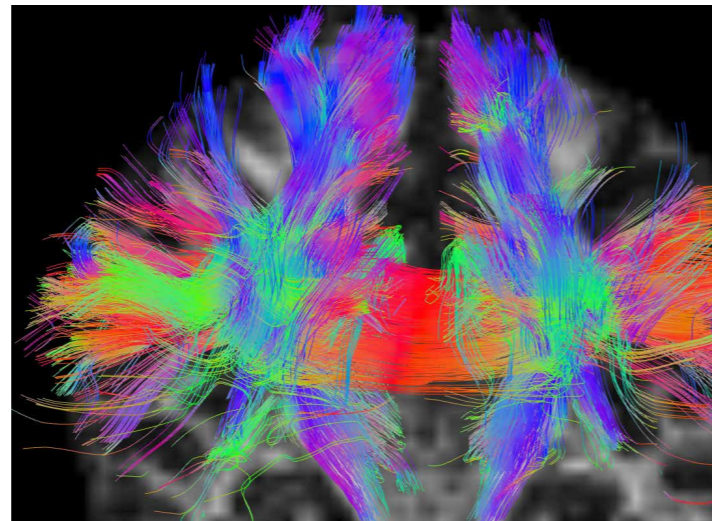
Track Advisor

Prof. Klaas Prüssmann
pruessmann@biomed.ee.ethz.ch

This track prepares you to work in the development and application of state-of-the-art imaging techniques such as magnetic resonance, ultrasound and microcomputed tomography. These methodologies are used to explore physiology and pathophysiology in humans and other living systems. Bioimaging has made enormous contributions to the diagnosis of human illnesses such as cardiac disease, Alzheimer's disease and osteoporosis. The current course programme can be found at: www.master-biomed.ethz.ch/education/bioimaging

Core Courses

- Biomedical Engineering
- Biomedical Imaging
- Image Analysis and Computer Vision
- Magnetic Resonance Imaging in Medicine
- Micro- and Nano-Tomography of Biological Tissues
- Molecular Imaging



Biomechanics

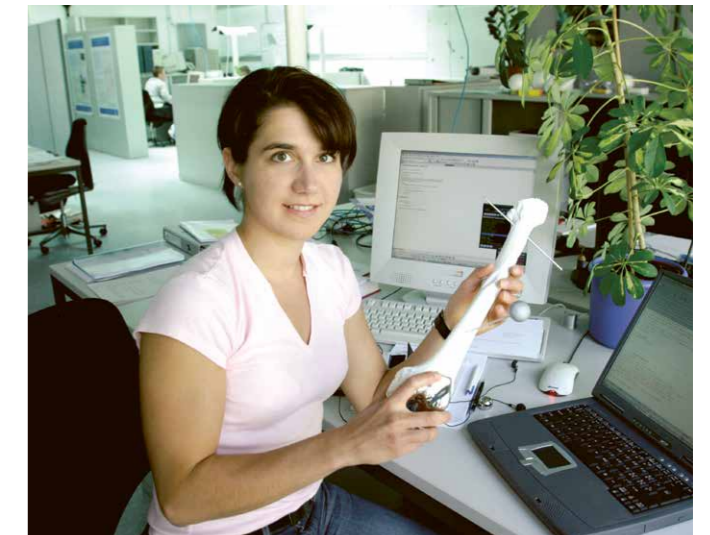
Track Advisor

Prof. Ralph Müller
ram@ethz.ch

This track gives you in-depth knowledge about the application of mechanics and measurement methods for understanding the structure and function of biological materials at the organism, organ, tissue, cell, and molecular level. The track includes many application fields ranging from cell biomechanics to fracture fixation and provides education and hands-on research opportunities in theoretical, experimental and computational biomechanics. Biomechanics is a discipline of biomedical engineering, which is increasingly influenced by cellular and molecular approaches. The course programme can be found at: www.master-biomed.ethz.ch/education/biomechanics

Core Courses

- Biomedical Engineering
- Biomedical Imaging
- Clinical and Movement Biomechanics
- Finite Element Analysis in Biomedical Engineering
- Image Analysis and Computer Vision
- Micro and Nano-Tomography of Biological Tissues
- Mechanobiology: Implications for Development, Regeneration and Tissue Engineering
- Medical Image Analysis
- Multiscale Bone Biomechanics
- Orthopaedic Biomechanics
- Trauma Biomechanics



Medical Physics

Track Advisor

Prof. Tony Lomax
alomax@ethz.ch

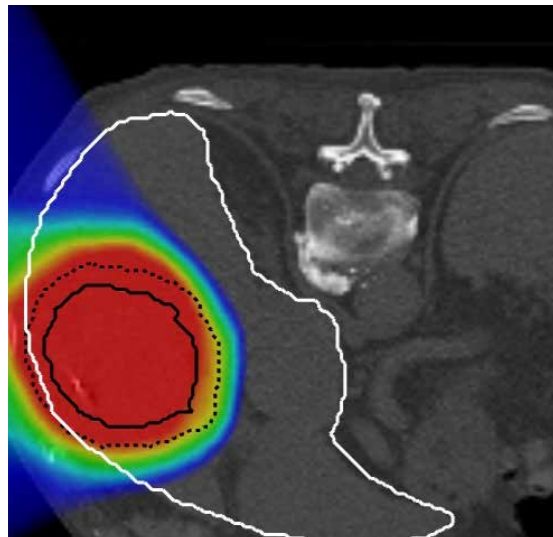
Prof. Marco Stampanoni
stampanoni@biomed.ee.ethz.ch

This track concentrates on the applications of physics to medical applications in radiotherapy and imaging. In addition to core lectures on medical imaging and radiotherapy, the track provides lectures on radiation biology and professional aspects of medical physics, together with various options in medical physics related subjects like hadron therapy and applied physics in the fight against cancer. Master's theses can be performed at PSI, ETH or various hospital based medical physics departments in Switzerland. The current course programme can be found at:

www.master-biomed.ethz.ch/education/medical-physics

Core Courses

- Biomedical Imaging
- Medical Physics I & II
- Radiobiology



Molecular Bioengineering

Track Advisor

Prof. Marcy Zenobi-Wong
marcy.zenobi@hest.ethz.ch

This track concerns the science and engineering behind the next generation of materials. Research topics include advancing the performance of medical implants, engineered tissues, nanoscale drug delivery systems, contrast agents for biomedical imaging, biologically inspired nanomaterials and devices, and the interfacing of cells with engineered nanosystems. The current course programme can be found at:
www.master-biomed.ethz.ch/education/molecular-bioengineering

Core Courses

- Biocompatible Materials
- Biological Engineering and Biotechnology
- Biostatistics
- Frontiers in Nanotechnology
- Fundamental of Biology IIA: Cell Biology
- Measuring on the Nanometer Scale
- Mechanobiology: Implications for Development, Regeneration and Tissue Engineering
- Physics in Medical Research: From Atoms to Cells
- Principles in Tissue Engineering



Institutes and Laboratories

Over 40 professors and researchers are associated with the MSc Biomedical Engineering programme through teaching, research and supervision of student research projects. Currently available Master's and semester project topics can be found under the individual websites as well as at: www.biomed.ee.ethz.ch

The following institutes and research laboratories are associated with the programme:

Institute of Biochemistry
www.bc.biol.ethz.ch

Institute for Biomechanics
www.biomech.ethz.ch

Institute for Biomedical Engineering
www.biomed.ee.ethz.ch

Bioengineering and Biotechnology Laboratory
www.bsse.ethz.ch

Bioprocess Laboratory
www.bsse.ethz.ch/bpl

Institute for Chemical and Bioengineering
www.icb.ethz.ch

Computational Science and Engineering Laboratory
www.cse-lab.ethz.ch

Computer Vision Laboratory
www.vision.ee.ethz.ch

Institute of Fluid Dynamics
www.ifd.mavt.ethz.ch



Laboratory of Food Process Engineering
www.ifnh.ethz.ch

Institute for Mechanical Systems
www.imes.ethz.ch

Micro- and Nanosystems
www.micro.mavt.ethz.ch

Institute of Molecular Health Sciences
www.imhs.ethz.ch

Nanophysics Group
www.nanophys.ethz.ch

Nanotechnology Group
www.nano.mavt.ethz.ch

Institute of Neuroinformatics
www.ini.unizh.ch

Institute of Pharmaceutical Sciences
www.pharma.ethz.ch

Centre for Proton Therapy at Paul Scherrer Institut (PSI)
www.psi.ch

Institute of Robotics and Intelligent Systems
www.iris.ethz.ch

Signal and Information Processing Laboratory
www.isi.ee.ethz.ch

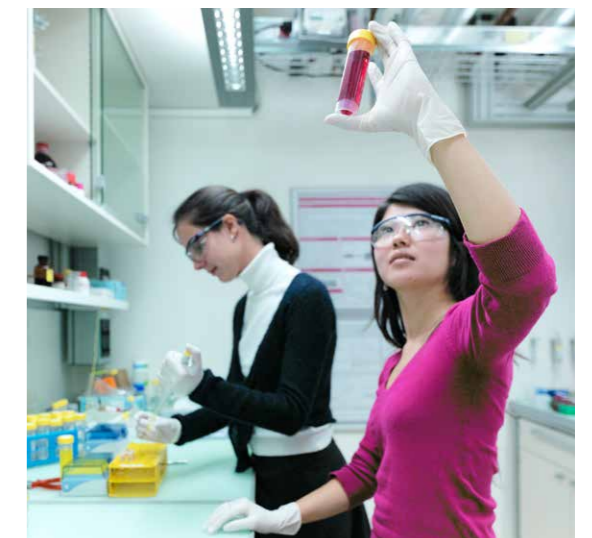
Laboratory for Surface Science and Technology
www.surface.mat.ethz.ch

Laboratory of Thermodynamics in Emerging Technologies
www.ltnt.ethz.ch

Institute of Translational Medicine
<https://itm.ethz.ch/>

University of Zurich, Medical Faculty
www.med.uzh.ch

University Hospital Zurich
www.usz.ch



Prospective Students

How to apply

Depending on the chosen track, the Master's Programme in Biomedical Engineering welcomes applications from students holding a Bachelor's degree in such various fields as engineering, physics, mathematics, computer science, biology, chemistry, medicine or health sciences and technology from an internationally recognized university. Details on qualifying Bachelor's degrees and additional requirements are published on the admission office's website:

www.ethz.ch/en/studies/master/application.html

Application deadlines and details on admission are given at: www.admission.ethz.ch

Tuition and Cost of Living

The tuition fee is 730 Swiss Francs per semester. However, students need to budget about 22,000 Swiss Francs (20,000 Euro) per year for living in Zurich (accommodation, living expenses, health insurance, etc.). A very limited number of scholarships are available for applicants with outstanding academic records. For more detail see:

www.ethz.ch/en/studies/financial

Continuing with Doctoral Studies?

Good Master's students may consider continuing their studies towards a doctor of science. Doctoral students are generally well paid. Applications should be made directly to a professor.

Biomedical Engineering Student Association at ETH (BEEZ)

www.facebook.com/ETH.beez



ETH Zürich

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. To researchers, it offers an inspiring working environment, to students, a comprehensive education.

Founded in 1855, ETH Zurich today has more than 22,000 students from over 120 countries, including 4200 doctoral students. Over 500 professors currently teach and conduct research in engineering, architecture, mathematics, natural sciences, system-oriented sciences, and management and social sciences. ETH Zurich regularly appears at the top of international rankings as one of the best universities in the world. 21 Nobel Laureates have studied, taught or conducted research at ETH Zurich, underlining the excellent reputation of the university.

Student Life

Zurich is consistently rated as one of the best places in the world to live. The city is situated on the beautiful lake of Zurich with the mountains less than an hour away. Zurich is clean and safe and has an excellent public transportation system and a high standard of living. The city has an international flair and offers many cultural activities as well as a vibrant nightlife. Most Swiss are multilingual and English is often the language of choice. Although German is not required for the Master's programme, some knowledge will make navigating the city and the university much easier. Language courses for students are available at: www.sprachenzentrum.uzh.ch. ETH Zurich itself offers a wide variety of sports, music, recreational and continuing education opportunities.

An overview can be found at: www.ethz.ch/en/campus

Information on every topic of life in Zurich is available in English at: www.zuerich.com/en



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Publisher: Department of Information Technology and Electrical Engineering
Editors: Dr. Christian Frei, Reto Kreuzer
Design: Communication and PR, D-ITET, ETH Zurich
Photos: ETH Zurich/Scanderbeg Sauer Photography (P. 1, 6–9, 12, 13),
Sebastian Kozerke (P. 5), Robert Vorburger (P. 8), Antje Knopf (P. 10),
Paul Scherrer Institut (P. 5, 10), Opto-E-Dura: A. Renz et al., Advanced Healthcare Materials, 2020 (P. 7)

Printed by Druckerei Kyburz AG

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