University of Basel

Swiss Nanoscience Institute

SNI
SWISS NANOSCIENCE INSTITUTE
EINE INITIATIVE DER UNIVERSITÄT BASEL UND DES KANTONS AARGAU

Annual Report 2017

Swiss Nanoscience Institute
University of Basel

The Swiss Nanoscience Institute (SNI) is a research initiative of the Canton of Aargau and the University of Basel.

This report summarizes work conducted at the Swiss Nanoscience Institute (SNI) in 2017.

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Content

Foreword

I am delighted at your interest in the Swiss Nanoscience Institute (SNI) and at this opportunity to present a brief review of the highlights of 2017.

If you are primarily interested in the SNI's scientific achievements, then I would refer you to the scientific supplement, which presents the results of all projects within the SNI PhD School and the applied Nano Argovia program. However, if you are looking for a general overview of the SNI, then I recommend browsing this, the main section of our annual report. Here you will find not only voices from around the SNI network, but also articles on a select number of research projects and reports on a range of SNI activities.

I am especially delighted to present the success stories of three of our young PhDs, who successfully completed their dissertations at the SNI last year and are now resolutely pursuing their future careers. In total, ten doctoral students from the first year's intake have now completed their doctoral dissertations. At the PhD School, we were able to provide them with comprehensive training and the opportunity not only to establish and present themselves within the SNI network, but also to get the most out of the many areas of the interdisciplinary nanosciences that we deal with at the SNI. They can now take what they have learned and apply it to the worlds of research and industry.

Our doctoral students were not the only ones responsible for this year's highlights. In addition, our departing graduates are now also beginning successful careers. The winners of the awards for the best master's thesis in nanoscience and the best doctoral dissertation in the Faculty of Science are examples of the sort of committed young people who successfully complete the demanding interdisciplinary nanosciences study program here at the University of Basel.

The section about Nano Argovia projects shows how industry can benefit from the expertise on offer in the SNI network. The Nano Argovia program brings together at least two academic partners with an industrial company from Northwestern Switzerland to address applied research questions. In this report, we introduce two Nano Argovia projects that are representative of the other exciting projects we undertake.

It goes without saying that our Argovia professors also have applications in mind for their research. In general terms, however, the current research projects of Martino Poggio and Roderick Lim are oriented more toward basic science and are somewhat further removed from practical applications. In any case, you will see for yourself how exciting basic research can be, how research is supported by a range of different services, and how we keep the public informed of our activities at the SNI.

I hope you enjoy reading our annual report, and I am always pleased to hear your feedback. If you would like more information about the SNI's activities, please do not hesitate to get in touch. We are always happy to help.

Kind regards,

Christian Schönenberger
SNI Director, March 2018

"I am delighted to present some highlights of 2017."

Prof. Dr. Christian Schönenberger
SNI, University of Basel

Swiss Nanoscience Institute

The interdisciplinary center of excellence for nanosciences in Northwestern Switzerland

The Swiss Nanoscience Institute (SNI) at the University of Basel is a center of excellence for nanosciences and nanotechnology and was founded in 2006 on the initiative of the Canton of Aargau and the University of Basel. In the SNI network, interdisciplinary teams of scientists conduct basic and applied research that actively supports knowledge and technology transfer to industrial companies from Northwestern Switzerland within the context of the Nano Argovia program. The SNI offers a degree program in nanosciences and a PhD school, providing young nanoscientists with interdisciplinary and practice-oriented training and preparing them for careers in industry and academia through a variety of activities. In addition to research and training, the SNI offers comprehensive imaging services through its Nano Imaging Lab. It is also involved in public relations and specifically supports initiatives aimed at interesting various target groups in the natural sciences and demonstrating the fruitful collaboration between academia and industry.

Commitment from the Canton of Aargau
The SNI was founded in 2006 by the Canton of Aargau and the University of Basel to promote research and training in the nanosciences and nanotechnology in Northwestern Switzerland. Nanotechnologies are highly relevant to research and industry in the heavily industrialized Aargau region. The numerous successful SNI research projects, in which scientists from various disciplines and institutions work together in one network, support the Canton of Aargau's high-tech strategy and offer companies from Aargau and the two Basel half-cantons access to new scientific findings and technologies. In 2017, the SNI had a total budget of 6.8 million Swiss francs, of which 4.5 million came from the Canton of Aargau and 2.3 million from the University of Basel.

A diverse, active network
The success of the SNI is based on the interdisciplinary network that has been built up and consolidated over the years. This network includes the Departments of Chemistry, Physics, Pharmaceutical Sciences, and the Biozentrum at the University of Basel, research groups from the Schools of Life Sciences and Engineering at the University of Applied Sciences Northwestern Switzerland (FHNW) in Muttenz and Windisch, the Paul Scherrer Institute (PSI), the Department of Biosystems Science and Engineering at the Federal Institute of Technology (ETH) Zurich in Basel (D-BSSE), and the CSEM (Centre Suisse d'Electronique et de Microtechnique) in Muttenz. The wider network also includes the Hightech Zentrum Aargau in Brugg and BaselArea.swiss, which promotes knowledge and technology transfer and ensures mutual assistance with events. Interdisciplinary academic conferences, meetings between project leaders and management bodies of the SNI, and active internal communication via a newsletter and the SNI website encourage and promote exchange within the network on an ongoing basis.

Excellent education for students
The University of Basel has offered bachelor's and master's programs in nanosciences since 2002. Today, these demanding degree programs are firmly established, with 79 students currently enrolled on the bachelor's program and 46 on the master's program. The students on the bachelor's program receive a solid basic education in biology, chemistry, physics, and mathematics and can subsequently choose from a wide range of practical and theoretical courses that allow them to focus on specific topics over the course of their studies. Early on in their education, they have the opportunity to participate in various research groups as part of block courses, something that is often highlighted as particularly motivating and valuable. In addition, students are given the chance to participate in courses outside their field of specialization. For example, the courses on media competence prove popular with students, as do those delivering effective job-hunting skills.

A variety of topics at the PhD School
To promote the further training of young scientists and a wide spectrum of basic scientific research, the SNI initiated a PhD School in 2013. In 2017, 42 doctoral students were enrolled. So far, ten young scientists have successfully completed their PhDs. They are now continuing their academic research as postdocs or have successfully made the move into industry. In 2017, seven new doctoral students were taken on, and a further seven new PhD projects were approved for 2018.

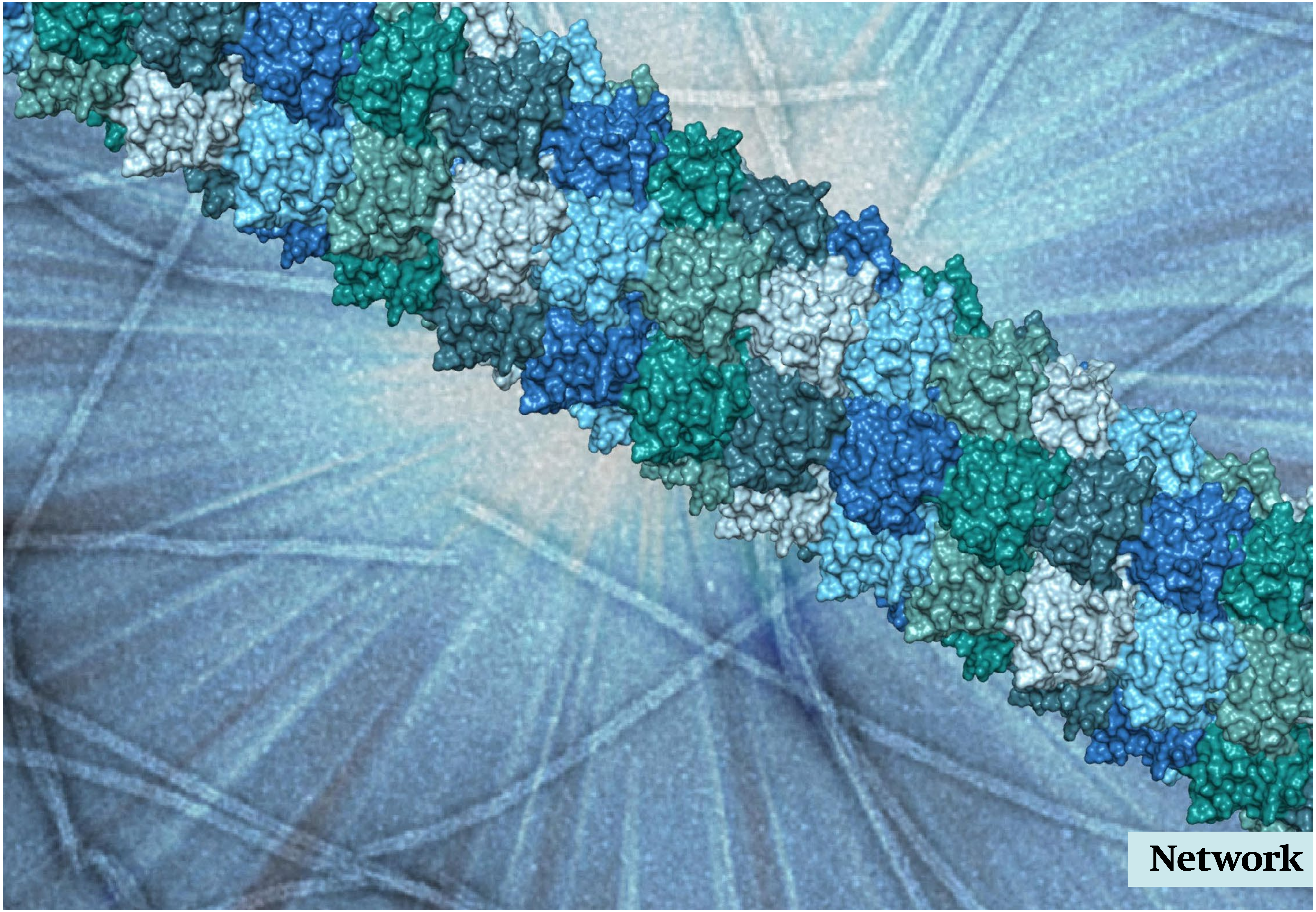
Within the SNI PhD School, each doctoral student is supervised by two members of the SNI network, who often belong to different departments of the University of Basel or partner institutions. The doctoral students' interdisciplinary education is further enhanced by participation in internal scientific events such as the Winter School 'Nanoscience in the Snow' and the Annual Meeting. Furthermore, the SNI offers the doctoral students a diverse range of courses to provide insight into topics such as intellectual property, communication, rhetoric, and career strategies and to help them forge contacts with industry.

Leaders in their field
Basic sciences form the foundation of research work at the SNI. In addition to the various projects funded as part of the PhD School, the SNI also supports the basic scientific research performed by Argovia professors Roderick Lim and Martino Poggio. The two professors once again contributed to the SNI's outstanding international reputation in 2017 with excellent publications in renowned scientific journals. In addition to the Argovia professors, the SNI supports three titular professors: Professor Thomas Jung teaches and researches in the Department of Physics at the University of Basel and leads a team at the PSI. Professors Frithjof Nolting and Michel Kenzelmann also lecture at the Department of Physics and are active with their research groups at the PSI.

Strong connections to practical application
The transfer of academic findings to industry has played an important role at the SNI since its inception. To optimize this process, the SNI launched an annual call for applied research projects. This program, entitled Nano Argovia, supports about ten projects each year in close collaboration with industrial companies in Northwestern Switzerland and has a total budget of around 1.3 million Swiss francs. Through the Nano Argovia program, the SNI provides an important bridge between research and application. In several cases, this collaboration has led to Commission for Technology and Innovation (CTI) projects and other follow-on projects and the registering of patents. Thirteen Nano Argovia projects were underway in 2017. Nine of the partner companies came from the Canton of Aargau, and four were from the two Basel half-cantons. In late 2017, seven new Nano Argovia projects were approved that will start in 2018, and six projects were extended.

Services in demand
The SNI is also on hand as a provider of various services for partners in academia and industry. At the heart of these services is the Nano Imaging Lab (NI Lab), which was founded in 2016. The NI Lab's five members of staff have decades of experience in electron and scanning probe microscopy and can provide comprehensive imaging services thanks to the lab's outstanding equipment and their expertise. The SNI also supports the excellently equipped workshops for technology, electronics, and mechanics in the Department of Physics. Research institutions and industrial companies can access both the expert knowledge of the staff and the outstanding technical resources of the SNI and affiliated departments.

Sharing the fascination with others
For the SNI, it is important to keep the public informed of its activities and to involve them in its fascination with the natural sciences. For example, the SNI team participates in science festivals and exhibitions, provides schools and groups of interested visitors with an insight into everyday laboratory life, and strives to produce materials for various target groups as well as press releases about outstanding research results to make the SNI's scientific achievements accessible to a wide audience. The newly designed website keeps visitors up to date with the various activities and provides information for different target groups. A new addition to the SNI program is the Nano Tech Apéro, which focuses on the successful collaboration that characterizes the Nano Argovia program.



Network

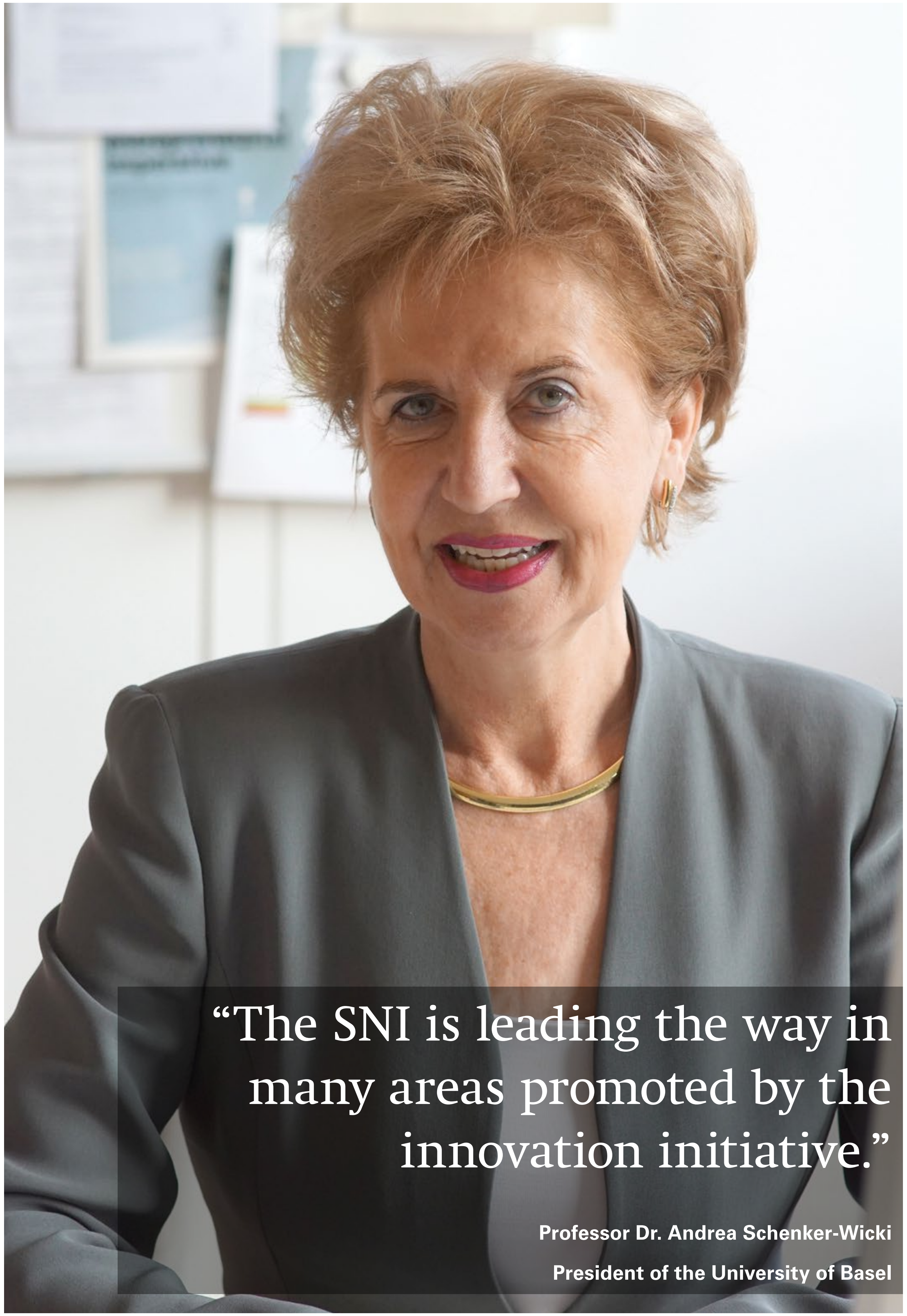
Positive impact through innovation

The President of the University of Basel encourages scientists to collaborate with companies and to set up new enterprises

Professor Andrea Schenker-Wicki, President of the University of Basel, has declared it her goal to improve society through innovation. To further this goal, the University of Basel created an Innovation Office in early 2017 and appointed a Delegate for Innovation. With the support of the Innovation Office, the University of Basel aims to establish a culture that will encourage scientists to start collaborating with industry and setting up their own companies at an early stage. The university is working to impart the necessary expertise, set up networks, and provide budding young entrepreneurs with all the support they need. For Andrea Schenker-Wicki, nanoscience is becoming increasingly important to innovation. She is delighted to see the SNI, which has been working hard for many years to maintain successful industry contacts, provide the University of Basel with a well-positioned research network.

New role in the 21st century
In November 2017, Andrea Schenker-Wicki opened the University of Basel's first Innovation Day in a garage in Allschwil – the same building in which pharma company Actelion began its success story many years ago. She discussed the role of universities in the 21st century, which will extend beyond teaching and basic research to a more active role in patenting inventions, licensing, and setting up companies. "As a publicly financed university, it is our duty to have an impact on society," she explains. "The cost of research is constantly rising, so we need effective knowledge and technology transfer to make better use of the knowledge generated." In her opinion, the university also has a social duty to its employees and students. Increasing digitalization and globalization will drastically change the world of work. New working conditions will develop that will offer great flexibility and demand new skills.

Innovation initiative at the University of Basel
The University of Basel has launched an innovation initiative to capitalize on its great innovation potential over the coming years. In early 2017, Christian Schneider was appointed head of the new Innovation Office. Professor Hans-Florian Zeilhofer – chief physician for oral and maxillofacial surgery, founder of several spin-off companies, and member of the steering committee for the SNI Nano Imaging Lab – has been named the Delegate for Innovation. Over the last few months, the Innovation



Office has established structures and networks required for collaboration between research and industry. The foundations have been laid to help students and researchers acquire the skills to set up businesses and to advise, support, and assist them in this process.

Bottom-up process

For Andrea Schenker-Wicki, it is clear that scientists must take the initiative in setting up a company or collaborating with industry, and that basic research will remain an elementary part of the university's research. "As a publicly funded university, we guarantee independent basic research – without basic research, there can be no radical innovation," she says. "Individual scientists can sometimes feel like they are walking a tightrope between publishing their results or protecting them with a patent. We help them where possible, but ultimately it's their decision," she adds.

She believes it is essential for the university to develop a new culture of innovation over the coming years – a culture in which setting up a company is a fun and exciting endeavor, in which failure is not a negative thing. "Mistakes happen and give us the opportunity to learn how to avoid making the same mistake again," she says. "The university offers its employees a good basis to try things out – there will be no consequences if a new company or industry collaboration doesn't work out as hoped."

The SNI is on the right path

Andrea Schenker-Wicki believes that the Swiss Nanoscience Institute (SNI) is leading the way in many areas promoted by the innovation initiative. The Nano Argovia program facilitates many successful collaborations with companies in Northwestern Switzerland, projects are created across disciplines and between institutions, bachelor's students visit companies to get a feel for applied research, and doctoral students are offered courses on intellectual property and patent law. "I am delighted that the Canton of Aargau supports the SNI, our well-positioned institute for the increasingly important field of nanoscience," she emphasizes. When asked if the SNI could do even better, she answers: "Doctoral researchers at the SNI could use the Innovation Office's services to acquire additional skills." These services include a range of courses and the Entrepreneurs' Club – an informal meeting of young entrepreneurs, students, and researchers with high-caliber guests invited to share their experiences. "If you have an idea for a start-up, I definitely recommend that you contact Christian Schneider at an early stage – then you can make sure things move in the right direction."

In addition to its good innovation framework, Andrea Schenker-Wicki links the SNI with the Kavli Prize awarded to Christoph Gerber in 2016: "It was a wonderful result for an outstanding invention," she recalls. She is also thrilled that SNI Director Christian Schönenberger has returned to good health following last year's serious accident and can continue steering the SNI to success.

The SNI network in brief

In the SNI network, interdisciplinary teams work closely on questions of basic and applied science and actively support knowledge and technology transfer with companies from Northwestern Switzerland. The SNI network includes various departments at the University of Basel, the Schools of Life Sciences and Engineering at the University of Applied Sciences Northwestern Switzerland (FHNW), the Paul Scherrer Institute (PSI), the Department of Biosystems Science and Engineering at the Federal Institute of Technology (ETH) Zurich in Basel (D-BSSE), and the CSEM (Centre Suisse d'Electronique et de Microtechnique) in Muttenz. The wider network also includes the Hightech Zentrum Aargau and BaselArea.swiss.

All scientists involved in Nano Argovia projects or projects at the SNI PhD School as project leaders or co-leaders automatically receive SNI membership – as do members of the SNI management and the Nano Imaging Lab – and therefore form part of the SNI network. As of 2017, former doctoral students at the SNI can become associate members and continue to participate in SNI events and enjoy access to the network for a further four years.

The Swiss Nanoscience Institute brings people together

Daniel Müller values his work as part of the SNI network

Professor Daniel Müller of ETH Zurich's Department of Biosystems Science and Engineering (D-BSSE), which is located in Basel, has been a member of the Swiss Nanoscience Institute for many years. In his research, everything centers around membrane proteins, which perform vitally important functions in our cells. He welcomes the Canton of Aargau's commitment to the nanosciences and praises the open, unbureaucratic culture at the SNI, which consistently allows him to conduct exciting research projects with colleagues from the University of Basel.

Research and development of devices

Daniel Müller came to Basel in 2010 to take over as leader of the biophysics group at ETH Zurich's Department of Biosystems Science and Engineering. He is now actively involved in numerous networks, such as the SNI or the NCCR Molecular Systems Engineering, and has set up an interdisciplinary group with 25 members of staff, all of whom work with membrane proteins in one way or another. These proteins are integrated into the membranes of cells and organelles and perform numerous vital functions, such as signal transmission or molecular transport. Within various projects, the biophysics team studies not only how individual membrane proteins operate, but also the interaction between multiple proteins and how they contribute to the perfectly coordinated operation of the cell. The scientists in Daniel Müller's team work mainly with multifunctional equipment based on atomic force microscopy, some of which they develop themselves.

Precise balance for individual cells

Recently, the team published details of a nanoscale balance that can be used to determine the mass of individual cells in a cell assembly. This balance was developed in close cooperation with Professor Christoph Gerber, SNI Vice-Director and recipient of the Kavli Prize. Based on a system of tiny cantilever probes, the technique records the cell mass over several days in millisecond steps and is accurate to within a few picograms.

The first step is to functionalize a tiny silicon cantilever probe – produced specially for this application by the Nano Imaging Lab – so that cells adhere to it firmly. The probe is placed in a special chamber, which was made by Sascha Martin from the Department of Physics' mechanics workshop. Inside this chamber, the humidity, gas composition, and temperature can be kept constant. In order to take the measurements, the chamber is placed under an optical microscope above a cell culture dish. The cantilever probe is then made to vibrate and brought into contact with a cell, which then quickly adheres to the probe. The attached cell alters the probe's mass and therefore its frequency of vibration, which can be determined using a laser and then correlated with the altered mass.

Outstanding teamwork

"The collaboration between Dr. David Martínez-Martín and Gotthold Fläschner from my team with Christoph Gerber, Sascha Martin, and Daniel Mathys from the Nano Imaging Lab was excellent. As a result, we were able to build a completely new tool. Now, we are able not only to observe but also to precisely measure changes in cell mass, which are a key parameter for many processes inside the cell," says Daniel Müller, commenting on the cooperation between his group and the different teams from the University of Basel. As other scientists around the world have expressed great interest in a cellular balance of this kind, Nanosurf AG (Liestal) has licensed the invention and is preparing a market launch of the so-called Cytomass Monitor.

Projects at the SNI PhD School and for students

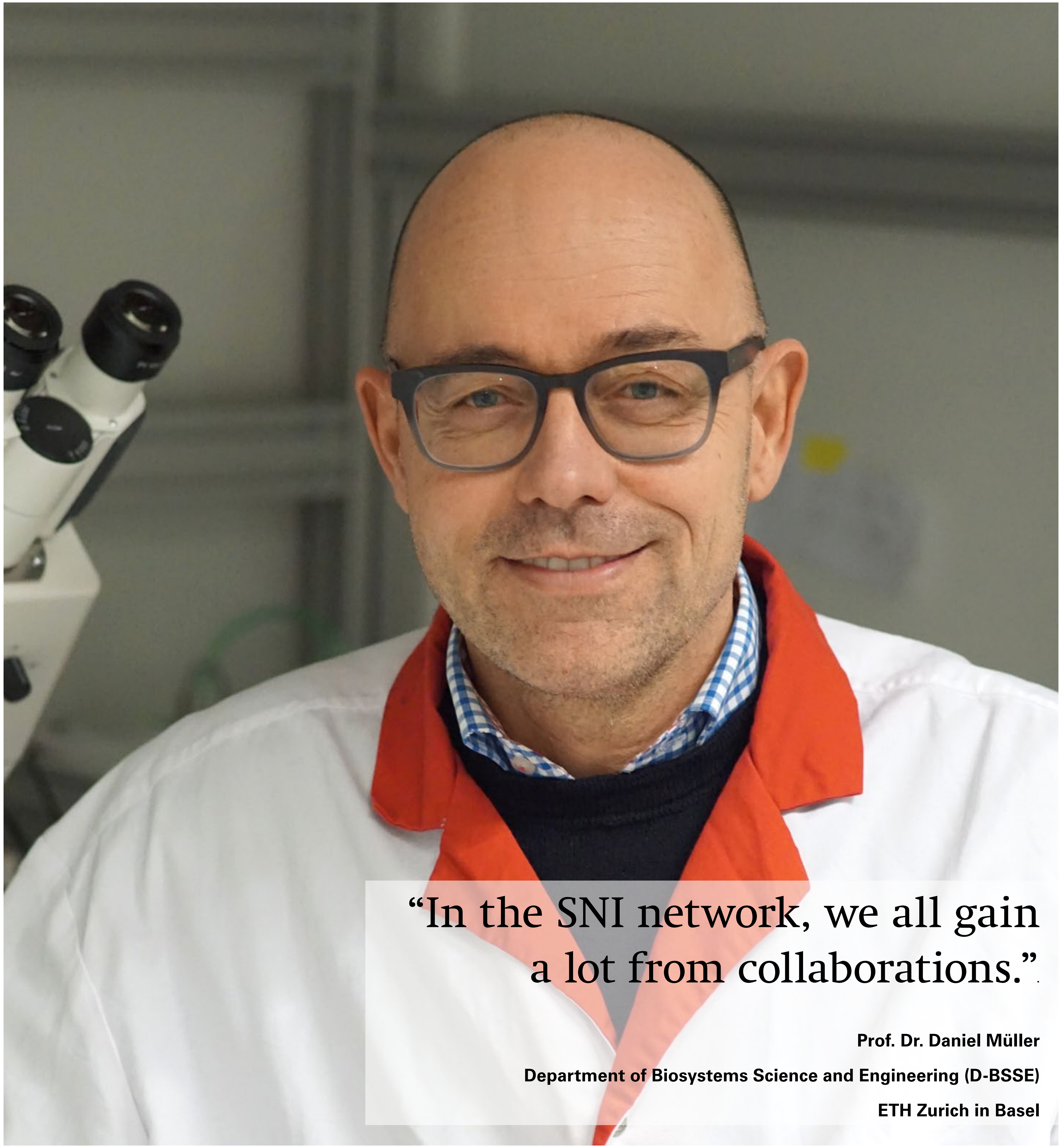
Daniel Müller not only collaborates with colleagues from the Department of Physics but also supervises joint projects with SNI Vice-Director Professor Wolfgang Meier from the Department of Chemistry and Professor Sebastian Hiller from the Biozentrum as part of the SNI PhD School. On the one hand, these projects center around proteins that are integrated into artificial vesicles. These proteins are involved in converting solar energy into chemical energy, which is then available for various molecular processes in the vesicles. On the other hand, they examine how membrane proteins fold after they are synthesized and, once folded, how they integrate into membranes. Understanding this process is vital for the later manufacture of tiny nanoreactors from artificial membranes with integrated functional proteins.

Students of nanosciences also regularly work in Daniel Müller's laboratory. "It's always good to have nano students in the group. They bring new energy to the laboratory, as well as expertise that complements the skills of our biotech students. It benefits everyone and provides an opportunity for mutual inspiration," Müller explains.

Proximity and exchange are vital

This exchange of ideas between scientists from different disciplines is also what Daniel Müller values so much about the SNI: "It's very generous of the SNI to allow us to participate in its projects as an ETH institute. As the SNI projects are always carried out with a partner, the allocated funding has to be shared, but the bottom line is that we all gain much more by collaborating." He also praises the SNI's streamlined, unbureaucratic, and excellently organized administration, which gives researchers the scope they need to focus on the actual task in hand – the research. "I'm a scientist first and foremost, and I'm always glad when I can spend as little time as possible on admin," he says.

With the construction of the new ETH building due to be completed in a few years' time, he is already looking forward to being even closer to his colleagues at the University of Basel, as discussions about scientific work provide him with inspiration and stimulate his creativity. However, opportunities already exist to cross paths with scientists from other departments and disciplines – for example, at the SNI's Annual Meeting or completely by chance as he takes his dachshund, Albert, for a walk around the university area near his home at Petersplatz. "It's always important to discuss things and to get together with people – that's how new ideas are generated. It's great that the Canton of Aargau and the University of Basel support an institute like the SNI and, by doing so, facilitate this process of ongoing communication," Müller concludes.



"In the SNI network, we all gain a lot from collaborations."

Prof. Dr. Daniel Müller

Department of Biosystems Science and Engineering (D-BSSE)

ETH Zurich in Basel

"Daniel Loss has made a considerable contribution to our theoretical understanding of spin dynamics and spin coherence in quantum dots, creating new areas of opportunity with practical applications for spin-based quantum computing."

King Faisal Foundation

In April 2017, Daniel Loss was awarded the King Faisal International Prize for Science

Recognition of concept for developing a quantum computer

Professor Daniel Loss, Vice-Director of the SNI and Professor of Theoretical Physics at the University of Basel's Department of Physics, received the King Faisal International Prize for Science in April 2017. Loss was awarded the prestigious science prize for his concept of a quantum computer based on electron spins. He first published the theory in 1998 in collaboration with Professor David DiVincenzo and has refined it over recent years, creating a new field of research known as quantum spintronics.

Impetus for a new field of research
Whereas today's digital computers break information down into zeros and ones (bits), quantum computers operate using a hybrid state, the qubit, which can represent both zero and one. Back in 1998, Daniel Loss and David DiVincenzo developed a theory whereby the intrinsic angular momentum – or spin – of electrons could be used as a carrier for these qubits. With this year's prize, the King Faisal Foundation gave recognition to the role of Loss's work in initiating a number of important experimental programs around the world and in opening the door to powerful quantum computers with extraordinary speed and storage capacity.

At the awards ceremony in April 2017, Saudi Arabia's King Salman presented the King Faisal International Prize for Science to Professor Daniel Loss and Professor Laurens Molenkamp (University of Würzburg, Germany), who has made significant contributions to the field of experimental spintronics.

Electron spins as the smallest memory unit
An electron's spin behaves in a similar way to a compass needle. Its direction is initially undetermined; that is, it points both up and down. This phenomenon of simultaneous states – known as superposition – is disturbed by interactions with the environment, for example when a measurement is taken, causing the electron to adopt a specific spin. The spins of neighboring electrons can enter into an extremely unusual form of connection that is known in quantum physics as entanglement. Manipulating the state of one spin – for example, by switching it to up or down – also alters the states of the entangled spins. Whereas a digital computer can only perform operations sequentially, entanglement would allow a quantum computer to perform them in parallel and to access the results simultaneously. Accordingly, a quantum computer could carry out calculations and simulations involving vast amounts of data that are beyond the scope of current computers.

Achieving the goal with quantum dots
In applying the theory proposed by Loss and DiVincenzo into practice, scientists are using nanoscale objects known as 'quantum dots', which are made of a semiconductor material. With a size of 10–100 nanometers, they behave in a similar way to atoms but are around 1,000 times larger. Inside each quantum dot, it is possible to trap and manipulate an electron, whose spin can then be controlled and switched electrically in response to electrical and magnetic fields.

In order to make use of the spins inside the quantum dots, it is important to maintain the superposition of the spin states for as long as possible and to prevent the electron's spin from being determined immediately by interactions with the environment inside the solid. The group led by Professor Dominik Zumbühl of the University of Basel's Department of Physics is exploring ways to delay this process, known as decoherence, for as long as possible. "My colleagues have made huge progress in this regard in recent years," says Loss. Whereas the coherence time – that is, the length of time for which different states can be kept stable – were initially measured in billionths of a second, Zumbühl's group currently holds the world record of one minute. This gives the scientists significantly more time in which to increase the number of switching operations, with a view to achieving the same sort of numbers as in current computers.

New approaches are needed

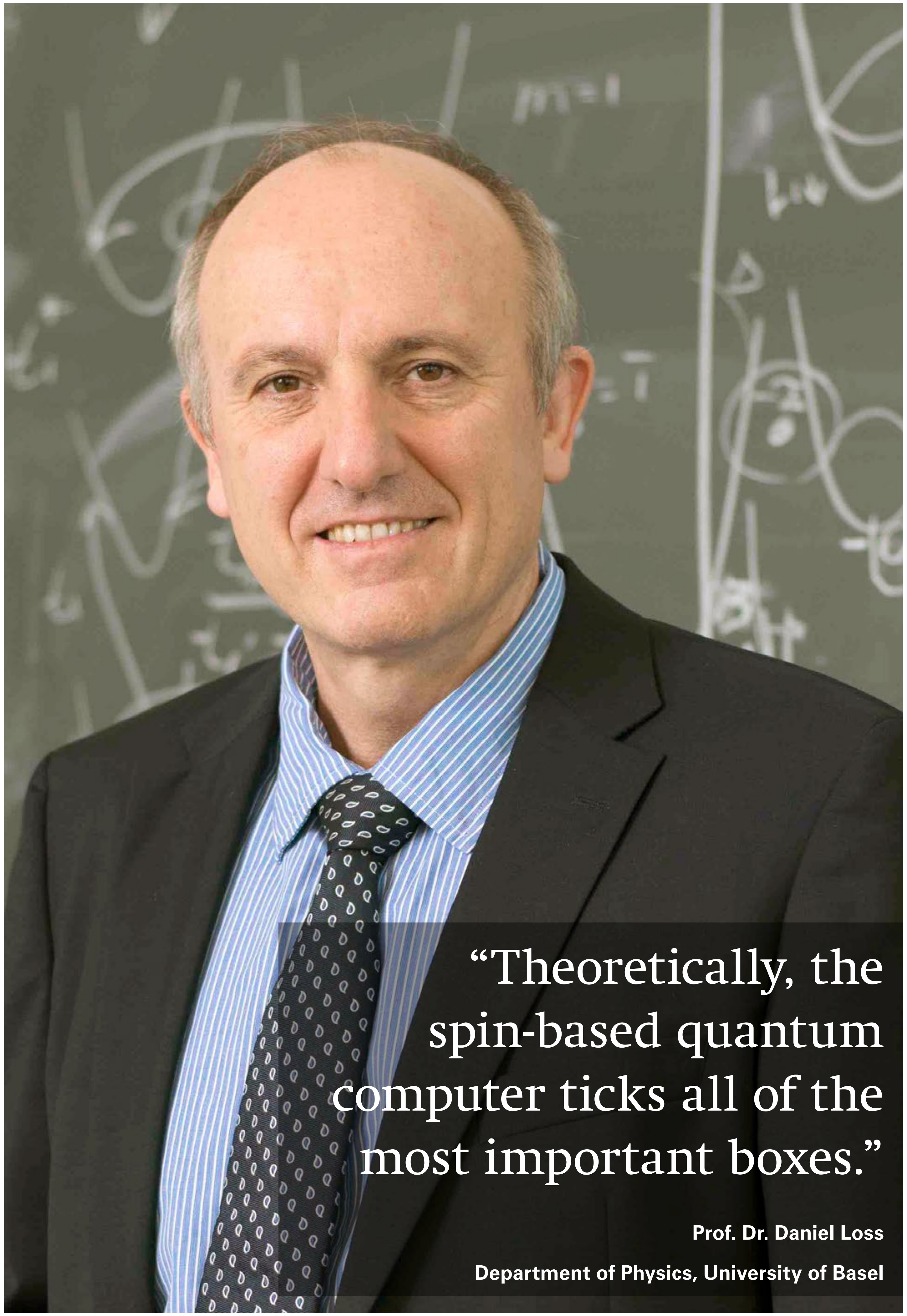
Before such a powerful quantum computer can become a reality, there is another unsolved challenge that must first be tackled: scaling. In order to compete with a current computer, a quantum computer would need around 108 spin qubits. Based on current knowledge, each qubit would have to be controlled by a wire, posing a major challenge in terms of space. Accordingly, new ideas are needed before the first working quantum computer like this can be built. Another unresolved question concerns the ideal choice of material. Whereas most research groups around the world work with gallium arsenide (GaAs), there are also approaches that use silicon and germanium.

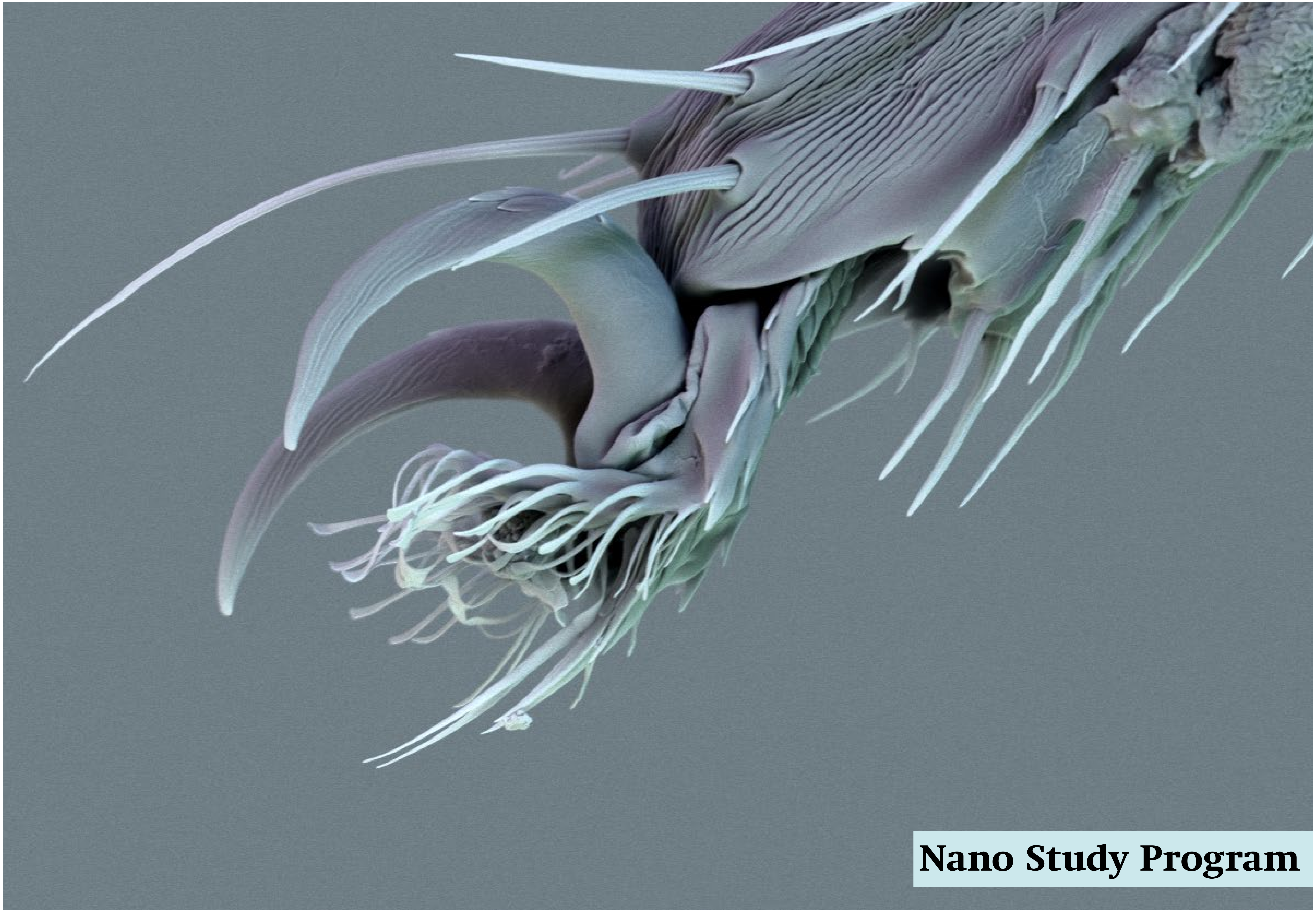
Despite the many unresolved issues, Loss remains convinced that his approach can be successful. "Theoretically, the spin-based quantum computer ticks all of the most important boxes," he explains. "It is fast, small, and integrable." Loss and DiVincenzo's quantum dot concept is just one of various approaches to developing a quantum computer, and the next few years will reveal which of them is likely to succeed.

The King Faisal International Prize

The King Faisal International Prize for Science has been awarded annually since 1984 by the King Faisal Foundation, which was founded in 1976. The prize is named after the Saudi Arabian King Faisal ibn Abd al-Aziz, who was the son of the country's founder.

In addition to the prize for science, the Foundation also awards prizes in the fields of medicine, Islamic studies, Arabic language and literature, and services to Islam. Awarded on an annual basis, the prizes are presented by the Saudi Arabian monarch at an awards ceremony in Riyadh. Many of the science prize recipients have gone on to receive the Nobel Prize.




Nano Study Program

Best master's thesis in nanosciences

Elise Aeby develops a new microfluidic platform

As part of the SNI Annual Event 2017, Elise Aeby was awarded the prize for the best master's thesis in nanosciences 2016. In her thesis, the young scientist developed a new microfluidic platform for the study of tissue cells. Now working on her doctoral thesis at ETH Zurich, she looks back on a fulfilling time at the University of Basel, where she not only acquired a broad range of knowledge and practical experience in various laboratories but also played an active role in a variety of SNI outreach activities. These provided her with an opportunity to share her fascination with the natural sciences.

Hanging drops
In her prize-winning master's thesis, Elise Aeby developed a microfluidic platform that can be used to study communication between various types of tissue, as well as the effects of different medicines. She undertook this work in the group led by Professor Andreas Hierlemann of ETH Zurich's Department of Biosystems Science and Engineering, which is based in Basel.

Hierlemann's group has developed a system whereby cultured cells are first suspended in a culture medium and then combined as hanging drops to form a microtissue. The cells inside this three-dimensional microtissue, also known as a spheroid, behave similarly to cells in a natural cell cluster. Using a system of tiny channels (a microfluidic system), they can be brought into contact with spheroids of another tissue and with active substances in conditions that closely resemble those inside the human body – unlike in the case of two-dimensional propagation in a petri dish. Until now, the system existed in an open form that was unsuitable for high-resolution microscopy.

Semi-closed system
In her master's thesis, Elise Aeby then converted this platform into a semi-closed system that is more robust and delivers better images for analysis. She did so by 'packing' the spheroids in hydrogel, thereby restricting their mobility without hindering the exchange of nutrients, waste products or oxygen. The platform is made of polydimethylsiloxane (PDMS) and contains tiny channels and culture chambers formed using soft lithography. These chambers are open, and the scientists can fill them with spheroids easily. In order to then seal the structures, albeit reversibly, Aeby fixed a thin glass plate onto the PDMS platform using a vacuum line. "The new platform combines microfluidic 3D tissue culture and high-resolution microscopy in a robust manner, allowing us to carry out long-term measurements over periods of more than 10 days, which were not previously possible," confirms her supervisor, Dr. Olivier Frey, a former senior assistant in Hierlemann's team.

Successful conclusion
For Elise Aeby, the prize-winning thesis represents a successful conclusion to the happy time she spent at the University of Basel. "I'm really glad I decided to study nanosciences in 2010," she says, looking back. She gained her first insights into nanotechnology when she completed an assignment on artificial muscles as part of her school-leaving certificate (Matura). Then, with every block course she took, as well as the project work and her master's thesis, she grew more and more certain that she was studying exactly the right thing – and she has passed this enthusiasm on to future students and other interested youngsters at numerous SNI information days and outreach events.

The young scientist, who grew up in Belfaux, now works in Professor Viola Vogel's team at ETH Zurich, where she is studying the applications of a tiny, newly developed robot that can be maneuvered in five degrees of freedom using eight electromagnets. Through this work, she continues to pursue her passion for the natural sciences.

“My degree in nanosciences provided excellent preparation and I would definitely choose it again.”

Dr. Adrian Najer

Former doctoral student at the University of Basel, currently a postdoc at Imperial College, London

A fantastic achievement for a young nanoscientist

Adrian Najer is awarded the faculty prize

As part of the Dies Academicus in November 2017, the University of Basel’s Faculty of Science awarded Dr. Adrian Najer the faculty prize for the best doctoral dissertation. In his prize-winning dissertation, Adrian Najer developed two innovative methods that could help to fight infectious diseases such as malaria. Prior to his dissertation, the young scientist studied nanosciences at the University of Basel.

Global threat

Infectious diseases continue to pose a threat to the health of billions of people, as reliable vaccinations are not available for such diseases and as a result of the increasing resistance of pathogens to the medicines currently in use. Completely new approaches are therefore needed in the fight against the various pathogens.

As part of his dissertation, Adrian Najer developed two different nanotechnology-based approaches to the treatment of infectious diseases. “As a typical model system, he focused his research on the infectious disease malaria, working hard to develop strategies that can block egressing parasites in the human bloodstream,” explains Professor Wolfgang Meier of the University of Basel’s Department of Chemistry, who supervised the dissertation alongside his colleagues Professor Cornelia Palivan and Professor Hans-Peter Beck of the Swiss Tropical and Public Health Institute.

Fooling parasites

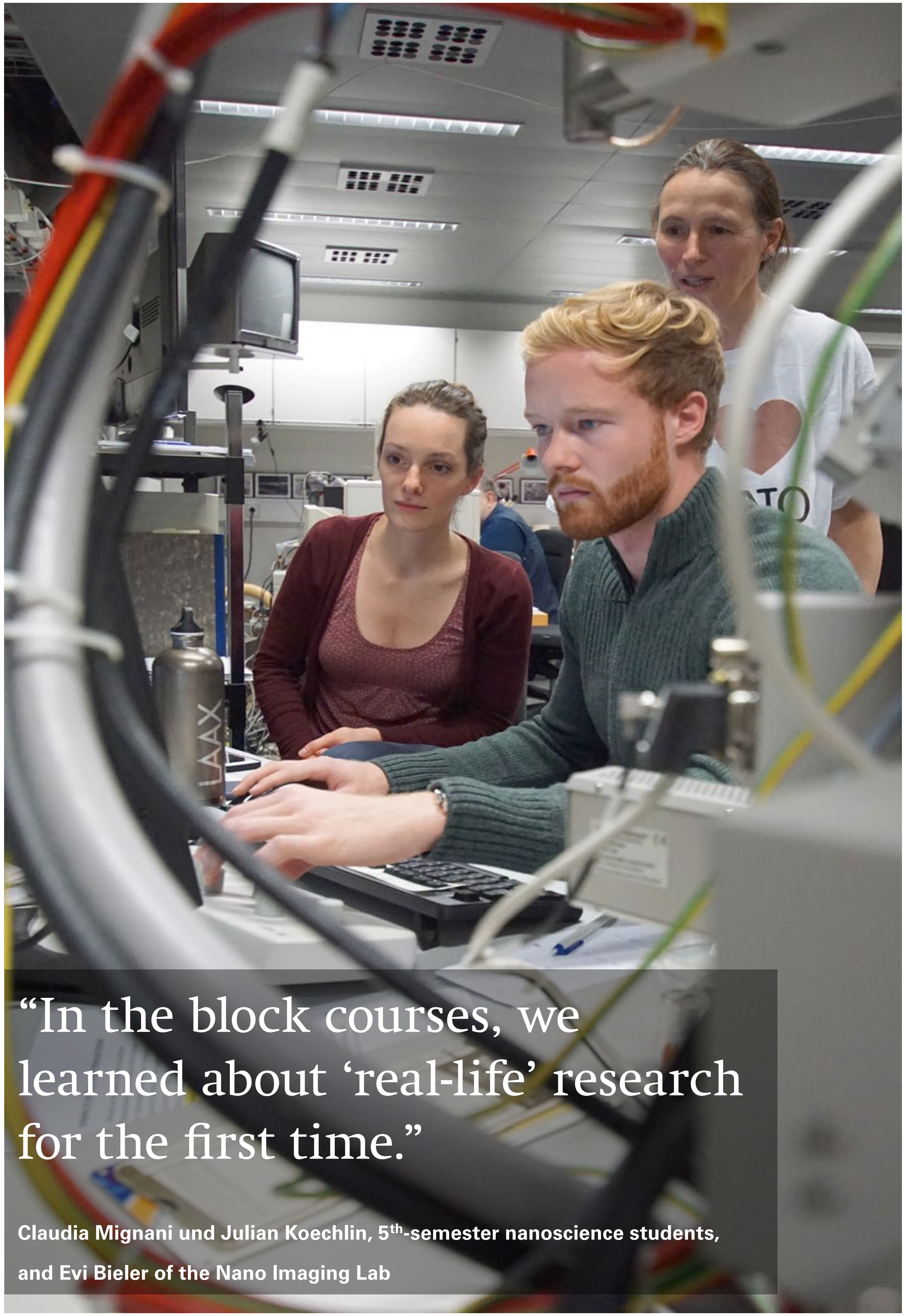
Transmitted by the *Anopheles* mosquito, the malaria parasites of the genus *Plasmodium* target red blood cells in the human body, infecting them and then multiplying inside. The infected blood cells burst, releasing parasites that go on to infect new blood cells. To stop this cycle in its tracks, Adrian Najer developed tiny polymer bubbles, ‘nanomimics’, whose surfaces carry specific sugar molecules that make them ‘look like’ red blood cells to the parasites. After the parasites are released, they therefore bind to these nanomimics, which block their mode of action. In theory, they should then be mopped up by cells from the immune system. “Here, we expect to see an effect similar to vaccination, which should protect against further infections,” Najer explains. “As numerous other pathogens use the same mechanism to identify host cells, this strategy could also be applied to other infectious diseases,” he adds.

Optimized release

In his work, Najer also sought to improve the distribution of unstable or poorly soluble medicines within the body by packing a drug inside tiny polymer particles. When parasites infect the red blood cells, there is a change in the environment inside the cells, causing the polymers to break down and release the drug. Uninfected blood cells do not absorb the particles, which therefore remain intact outside the cells with the drug packed inside them.

Strong motivation

Najer laid the foundations for this outstanding work during his degree in nanosciences. He was, and still is, primarily interested in using chemical or physical approaches to understand and influence biological processes, and the nanosciences provide him with an ideal way to bridge these disciplines. Throughout his doctorate and now as part of his postdoc fellowship as an SNF Early Postdoc Mobility Fellow at Imperial College London, he has also been motivated by the fact that his research is highly relevant. “Worldwide, around half a million children under the age of five die of malaria each year,” he says. “Through my research, I want to help solve this multifaceted and complex problem, and I’m convinced that a nanotechnology-based approach represents a step in the right direction.”



“In the block courses, we learned about ‘real-life’ research for the first time.”

Claudia Mignani und Julian Koechlin, 5th-semester nanoscience students, and Evi Bieler of the Nano Imaging Lab

Early participation in current research projects

The block courses are a highlight of the bachelor’s program

When we ask students about what they like best about studying nanosciences, they often cite the block courses in the bachelor’s program. In these courses, the students complete eight internships in different working groups in the SNI network and thereby gain an insight into current research at an early stage of their university education. At the same time, they not only familiarize themselves with new techniques and the laboratories’ state-of-the-art equipment, but also learn a great deal about scientific work. A wide variety of block courses are available, allowing students to sample a whole range of different subject areas.

Eight insights into current research

In the 5th and 6th semesters of the bachelor’s program, nanoscience students complete eight internships, known as block courses, in various working groups of the SNI network. At present, the students can choose from a wide range of 37 different courses. Various working groups from the University of Basel’s Department of Physics, Department of Chemistry, and Biozentrum, as well as the SNI’s Nano Imaging Lab, offer three-week, part-time courses, in which students spend their afternoons getting to know various different areas of the nanosciences. Network partners, such as the Paul Scherrer Institute, the FHNW Schools of Life Sciences and Engineering, the Swiss Federal Laboratories for Materials Science and Technology (Empa), and the Adolphe Merkle Institute, offer one- and two-week intensive courses in which the young researchers then immerse themselves in the nano world on a full-time basis.

A broad, diverse range of courses

The spectrum of courses on offer is enormously varied. Some of the subject areas are already familiar to students from the Nano I lecture course in the first semester, while other courses build on previous internships or are completely new to students. Whereas the early semesters offer relatively little freedom of choice, with all students studying the same basic principles, the block courses provide students with an opportunity to shape two semesters according to their own interests alongside a number of compulsory lecture courses. “In the block courses, you can put what you’ve learned in the first two years into practice. This helps to expand your understanding of the subject matter right across the board,” says Corinne Matte, a nanoscience student in her 5th semester.

For example, the students have a choice between courses about proteins, polymers, or metal-containing molecules. In others, they study the transport of molecules in and out of the cell nucleus. Nanolithography is another of the topics, along with various microscopic analysis methods (scanning probe, electron, or X-ray microscopy). The students have a chance to learn how to handle ultracold atoms, how to perform computer simulations, how surfaces can be modified in a specific way, or which new methods are used to study individual cells. The topics on offer include research tasks rooted entirely in the fundamental science surrounding carbon nanotubes or graphene, as well as applied topics such as the investigation of biocompatible materials for medical applications or the fabrication of composite materials for aviation.

At the same time, however, the block courses are a chance for students not only to learn about these and other fields of research, but also to make contacts that will help them at a later stage, during their master’s studies, to complete exciting projects and master’s theses in various research groups. “The block courses are a great opportunity to gain your first insights into the work of research groups,” says Julius Winter, a nanoscience student in his 11th semester, who has just completed his master's thesis at the Biozentrum. They also offer the supervisors of block courses a chance to get to know promising candidates for projects, master's theses, and doctoral dissertations.

Geared toward current research

The topics vary from year to year, as the students are generally integrated into current research. They work in small groups and therefore enjoy individual supervision by PhD students, postdocs, and professors. In the process, they not only gain an overview of different areas of research, but also learn how to handle state-of-the-art technologies and equipment. They learn how to conduct scientific work, what safety rules apply in the laboratory, and how data is recorded and analyzed. "In the block courses, I've learned what 'real-life' research means for the first time," says Julian Koechlin, a nanoscience student in his 5th semester.

To ensure that the block courses are distributed as fairly as possible, studies coordinator Dr. Katrein Spieler authorized the development of a type of auction software. Given the limited number of places on each course, this tool ensures that as many students as possible attend the courses they chose and are therefore able to influence the direction of their own studies. For proof that this approach is sustainable, you need look no further than this quote from the 2017 faculty prizewinner, Dr. Adrian Najer, who still has a clear memory of his block courses even many years later: "The SNI has found a brilliant solution with the block courses! I'm not aware of any other degree program where you get a direct insight into current, diverse, unfiltered, real-life research at such an early stage of your degree – highlighting the advantages and disadvantages of life as a researcher. You learn early on how scientific publications are built up and how to organize your research and data."

The Nano Study program in brief

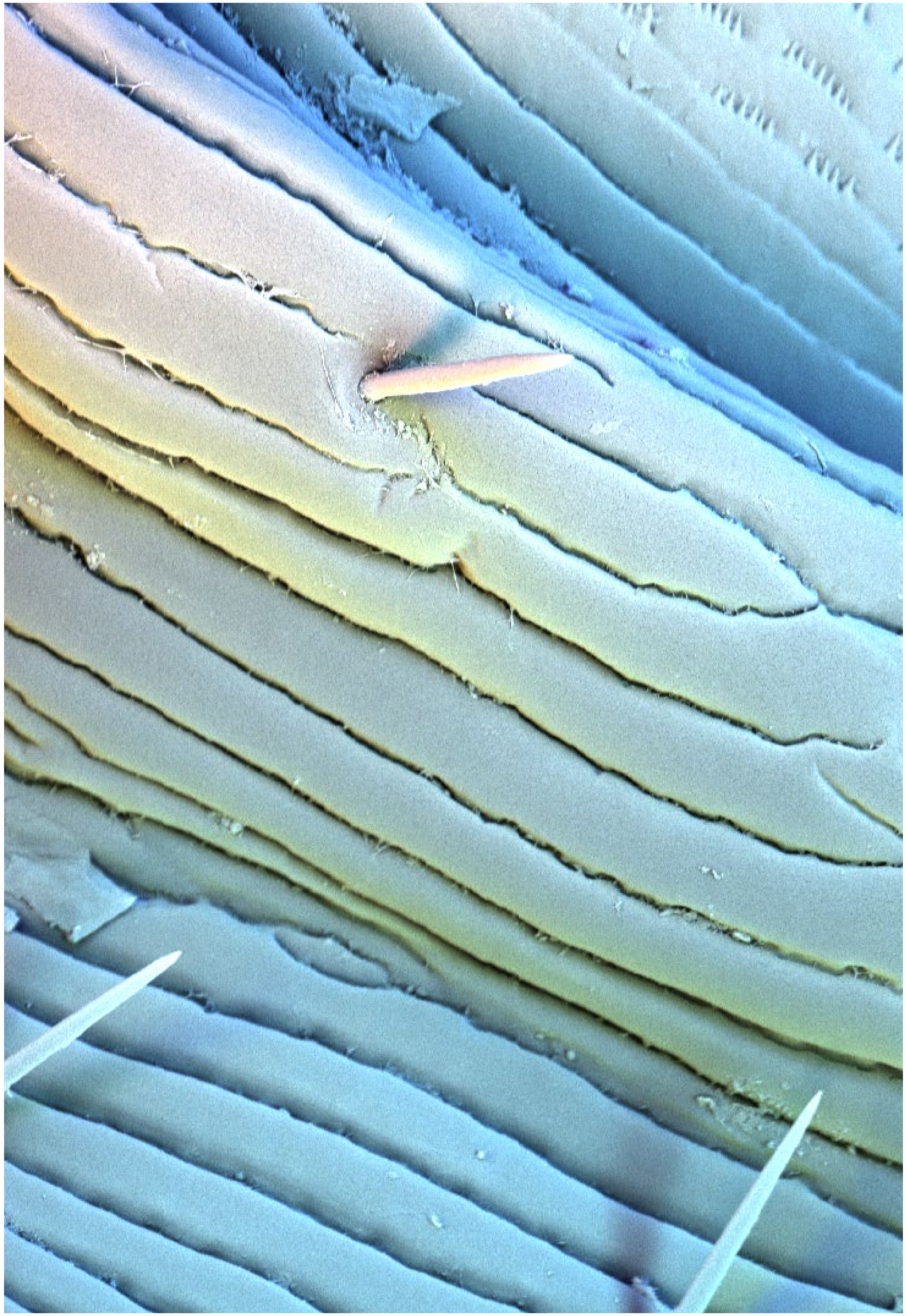
Since 2002, the University of Basel has been the first Swiss university to offer an interdisciplinary course of studies in nanosciences. Students can complete both a bachelor's and a master's degree as part of this practice-oriented program. In 2017, 79 students were enrolled on the bachelor's program and 46 students on the master's program. 24 students were awarded a bachelor's degree and 11 successfully completed their master's degree. 2017 saw one Erasmus student come to Basel from Sweden and five students from Basel took advantage of SNI grants to complete projects or master's theses at renowned institutes abroad. These included the Dana-Farber Cancer Institute at Harvard Medical School in Boston (USA), the University of California, Santa Barbara (USA), McGill University in Montreal (Canada), the Lund University (Sweden), and the Institute for Bioengineering of Catalonia (Spain).

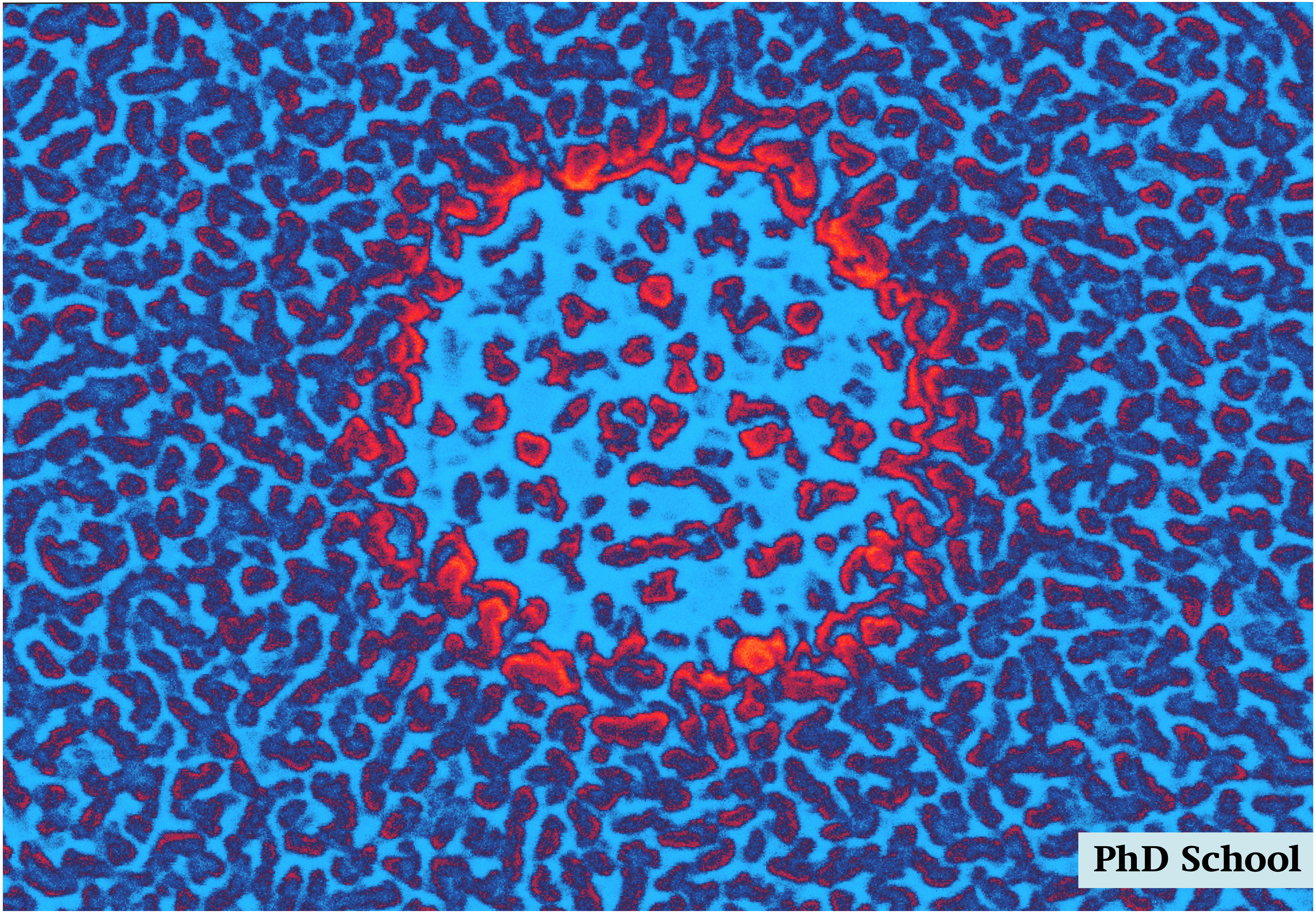
In 2017, the SNI was able to further expand the wide range of block courses for bachelor's students, giving them 37 different courses to choose from. These block courses provide students with an opportunity to work in various research groups at the University of Basel, the University of Applied Sciences Northwestern Switzerland (FHNW), the Paul Scherrer Institute (PSI), the Swiss Federal Laboratories for Materials Science and Technology (Empa), and the Adolphe Merkle Institute. As a result, the students gain practical experience and an insight into the everyday research of various teams. They also establish valuable links with working groups across the SNI network, which often lead to subsequent projects and master's theses.

A new addition to the program in 2017 was a workshop organized by the students themselves, in which they present selected topics from the block courses. To accompany the block courses, the students took part in practical exercises in which they received coaching on how to present scientific content. In January 2018, they presented what they had learned at the public workshop and were evaluated by a mixed panel. Overall, the event was very well received and will be held once a year from now on.

The SNI aims to make nanoscience students aware of links to practical applications at an early stage of their education. Accordingly, the students visit various companies as part of the Nano II lecture course and thereby gain an insight into applied research. In 2017, this program included ABB, BASF, Glas Trösch, Mibelle, Nanosurf, Rolic Technologies, and Sensirion as well as the research organization CSEM.

The nanoscience students have been an active community for many years, supporting one another with their studies and working together in a spirit of solidarity. In 2017, they not only launched an interesting and attractively presented student magazine, but also participated in the production of a short video clip in which they explain what makes the Basel nanosciences program so appealing.





PhD School

All it took was one application

Stefan Arnold is delighted with his job at Sensirion, which he was offered within a very short time

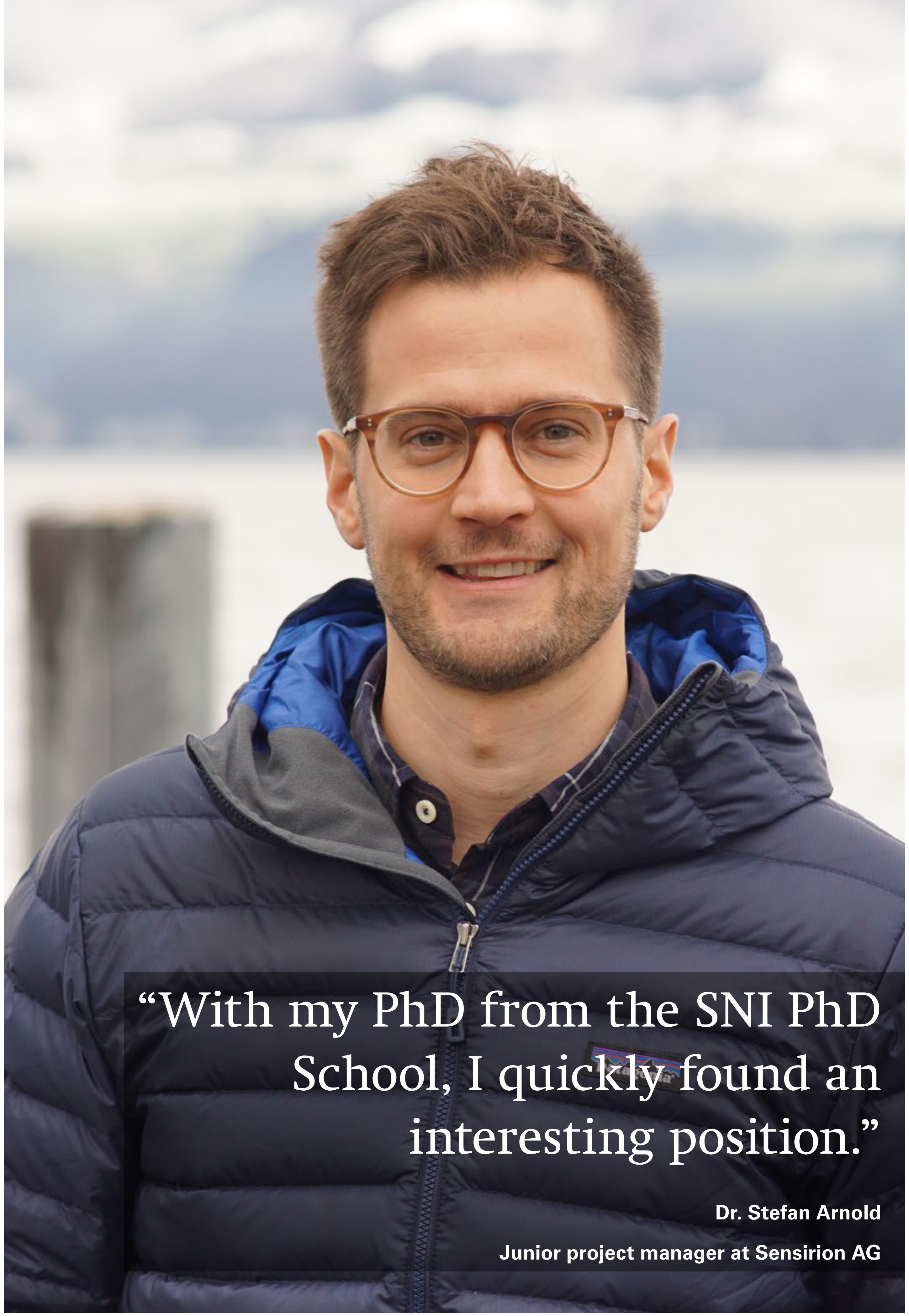
Stefan Arnold studied nanosciences at the University of Basel before going on to complete his doctoral dissertation at the SNI PhD School. Working at the Biozentrum's Center for Cellular Imaging and Nano Analytics (C-CINA), he developed a platform that allows the automatic preparation of proteins from individual cells for analysis. Key milestones on the road to his dissertation included two patents, four publications, and participation in two Nano Argovia projects. After that, the job application process was quick and easy. Just three weeks after finding an interesting position on the Sensirion AG website, Stefan Arnold was offered his first job as a junior project manager at the Stäfa-based company.

From Fribourg to Basel
At school, Stefan Arnold was most interested in biology and physics. After obtaining his Maturität certificate, Stefan heard about the nanosciences degree program in Basel and traveled from his home city of Fribourg to attend the university's information day. Wasting no time, he began his degree in nanosciences in 2006. Like so many other nanoscience students, he particularly liked the familiar atmosphere and the sense of team spirit. Another highlight, he says, was the practical work within the block courses, which offer an insight into the work of various research groups.

Project work at C-CINA
The second project was a decisive moment in his career and led him to Dr. Thomas Braun's group at C-CINA (Biozentrum). There, the plan was for him to develop a microfluidic chip for processing cells in collaboration with the team led by Professor Andreas Hierlemann of the Department of Biosystems Science and Engineering at the Federal Institute of Technology (ETH) Zurich in Basel (D-BSSE). "However, the chip didn't work as we'd imagined," says Stefan Arnold. "After doing some online research, I had the idea of developing a system with microcapillaries for processing individual cells."

It did not take long to convince Thomas Braun that this would make a great topic for a master's thesis, and so Stefan began building a prototype that could be used to isolate proteins from individual cells. After completing his master's thesis, he left Basel for a nine-month research placement at CSEM (Centre Suisse d'Electronique et de Microtechnique) in Graubünden. Just as he was considering his next step, the SNI PhD School was founded and Thomas Braun offered him the chance to return to Basel and work on a dissertation at the SNI.

A familiar topic and a new beginning
As part of his doctoral dissertation, Stefan initially began developing a microfluidic platform for the isolation of nanocrystals. However, various problems led him to abandon this approach and he returned to analyzing individual cells, a topic he had been enthusiastic about since he worked on it during his master's thesis. "I completely redeveloped the setup, optimizing the liquid handling, automating many of the steps, and developing and implementing novel preparation methods for electron microscopy. I really enjoyed the engineering work this involved," he recalls. Thanks to his dedication and four years of development work, the team now has a compact, effective, and largely automated system at its disposal.



The first step uses a cell culture to grow the cells whose proteins are to be analyzed. Specific individual cells can then be selected under an optical microscope, the cell membrane is made permeable using an electric field, and the entire content of the cell is sucked up by a microcapillary into a few nanoliters in a matter of seconds. Depending on the planned analysis technique, this lysate is then applied to specific microscope slides for further treatment.

“Unlike when a whole cell culture is processed, this approach gives us a precise overview of the contents of individual cells. It also reduces the stress on the cells, as they are still living in their cell assembly and interacting with one another until a few seconds before processing,” Stefan Arnold explains.

In order to prepare the proteins of individual cells for cryo-electron microscopy, the system was also refined so that it automatically plunges the slide into liquid ethane. “In short, I simply miniaturized and automated Jacques Dubochet’s brilliant idea for vitrifying liquids, for which he was recently awarded the Nobel Prize in Chemistry,” says Stefan Arnold. Stefan and his colleagues registered two patents to protect this development. The researchers patented the system that enables them to control the coating thickness of the applied sample, and also felt that the specific, automated sample preparation process for cryo-electron microscopy was worthy of protection.

Stefan Arnold’s expertise was also in demand in the Nano Argovia SCeNA project, in which he combined his existing setup with other analysis methods. For example, in collaboration with Dr. Gregor Dernick from F. H. Hoffmann-La Roche and Dr. Christian Berchtold from the University of Applied Sciences Northwestern Switzerland (FHNW), two new platforms were developed to analyze the contents of individual cells using protein microarrays and mass spectrometry.

Faster than expected

In March 2017, Stefan Arnold became the second doctoral student to complete a dissertation at the SNI PhD School. As part of the Nano Argovia MiPIS project, he wanted to remain at C-CINA as a postdoc, albeit for a maximum of one year. “I was still enjoying the work, and summers are always great in Basel,” he reminisces. In August, however, he began looking around to see what sort of jobs might appeal to him and came across an interesting advert on the Sensirion website. “I was already very familiar with Sensirion, as we had visited the company during the second semester of our degree, and then later I regularly accompanied students on the excursion to Sensirion,” Stefan tells us.

“I had taken a number of transferable skills courses at the University of Basel during my dissertation, so it was easy for me to complete my CV and write a good cover letter.” Just a week after submitting the application, he was invited for a first interview. “I was then very quickly invited to a second round, and I was on my way home from those meetings when I was offered the job.”

A great fit all round

Since November, Stefan Arnold has been employed at Sensirion in Stäfa as a junior project manager in the Liquid Flow Products development department. As part of this job, he is involved in developing a single-use flow sensor that precisely measures the flow rate of liquids in a channel.

“A sensor of this kind could be used for the accurate measurement of drug infusions in real time,” Stefan explains. In addition, the sensor could record whenever air bubbles passed through the channel and whether the infusion was actually entering the bloodstream. “It’s a lot of fun working at the interface between research and the product,” he says. Having a specific goal in mind was a source of motivation during his doctoral dissertation, and now spurs him on to develop innovative devices that appeal to customers.

In addition to the exciting scientific and technical challenges, the 32-year-old’s first position after his dissertation suits him in every way: The team, the positive collaboration, and the company culture at Sensirion, not to mention the beautiful surroundings, which offer no shortage of ways to enjoy his spare time.

Discipline and sheer fascination lead to success

Tomaž Einfalt developed artificial organelles

As part of his doctoral dissertation, Tomaž Einfalt developed artificial organelles in which various enzymatic transformations can occur. Arriving in Basel from Slovenia in 2013 to attend the SNI PhD School, the young scientist was supervised by Professors Cornelia Palivan and Jörg Huwyler. While working on his doctoral thesis, Tomaž enjoyed the interdisciplinary flair and excellent equipment both within his working groups and at the SNI – and he learned a great deal. Sports served as an important counterpoint to his research. He showed immense discipline, training before and after long days in the laboratory, and achieved remarkable successes as a triathlete. In addition, he played an active role as a representative of SNI PhD students and in SNI outreach activities, as well as establishing a wide circle of friends in Basel. Immediately after his doctorate, Tomaž continued his work in Professor Jörg Huwyler’s laboratory as a postdoc.

An attractive mix

Tomaž Einfalt came to the University of Basel in 2013 after studying pharmacy in Ljubljana (Slovenia). He had seen a PhD project advertised with Professors Cornelia Palivan and Jörg Huwyler and was immediately attracted to the mix of physical chemistry and pharmacy that the project would involve. His aspirations at that time were ultimately realized. “There is probably nowhere else I could have learned as much as I have done here in the last four years,” he tells us in our interview. “For me, the SNI PhD School is not simply a funding opportunity for PhD students, but rather an environment in which new ideas are generated and good friendships are formed between budding researchers,” he adds. Indeed, that is precisely what the SNI PhD School strives to be: an interdisciplinary community in which people learn from one another and that provides space for new ideas.

Artificial organelles

In his doctoral thesis, Tomaž studied artificial organelles. In the future, these could be used to transport precursors of a pharmaceutical agent to the site of action inside the body, for example. Only once they reached the target site would the precursors be converted into the active substance, before being released in a targeted manner. Administering drugs in this way could considerably reduce both the amounts used and the side effects, as the active substances would only be produced and released in the desired tissue.

In simplified terms, the artificial organelles are tiny hollow spheres, also known as polymersomes, which form spontaneously in solution from amphiphilic polymers and can enclose various elements, such as enzymes. Working with his colleagues from Palivan’s team, Tomaž succeeded in equipping the polymer membrane with a pore, whose permeability can be controlled by external factors. He incorporated chemically modified natural membrane proteins into the membrane. As these proteins open and close depending on the pH value, they allow the targeted exchange of substances with the surroundings. At a neutral pH, the membrane proteins are impermeable – that is, no substances can pass. If the pH of the surroundings becomes slightly acidic, however, the protein gate opens. Substances from the outside can

enter the polymersome, where they are converted thanks to the enzymes inside. The product of the reaction – a pharmaceutical active substance, for example – can leave the polymersome through the open gate and act directly at the target site.

Effective in living organisms

For his research project, Tomaž Einfalt first prepared these artificial organelles and tested the opening mechanism. Then, he managed to integrate the polymersomes into natural cells and to demonstrate that the system works excellently, even in live zebrafish. “We think that a mechanism of this kind could be effective when applied to inflammation and tumors in particular, as these are often found to have a slightly acidic pH,” he explains. Together with his colleagues, he has registered two patents, which are intended to protect the innovations derived from his work.

Tomaž continues to be fascinated by the opportunities that polymersomes offer. In his current position as a postdoc in Jörg Huwyler’s laboratory, one of the topics he is working on are liposomes (small hollow spheres with a membrane consisting of phospholipids), which he tracks as they spread throughout the body. He models this using zebrafish, which are so transparent that the liposomes can be stained with a fluorescent dye and then observed inside the living organism using a fluorescent microscope.

Enthusiasm for research and varied extracurricular activities

Tomaž hopes to continue working in research. In the medium term, however, he is also open to the idea of going into industry and can also imagine founding his own company one day. The important thing for him at the moment is to stay in Basel. After his degree in Slovenia and ERASMUS placements in Germany and England, and the numerous relocations this involved, he is glad to have found an ideal place to base himself.

He still spends about 15 hours a week training – on the bike, in the water, or running in the forest. Whereas two years ago he still found time to successfully compete in the European Triathlon Championships, triathlons are off the agenda for now. However, that does not mean that sport is any less important to him. As a competitive athlete, he continues to seek out challenges and also has the discipline to face and overcome them.

The remarkable thing is that, despite the amount of work this entails, Tomaž still finds the time and energy to get involved in other activities. During his doctorate, he represented the SNI’s doctoral students as a representative of the SNI PhD School. He participated in so many SNI outreach activities that he was awarded the SNI’s Outreach Award in 2016. He recently took part in the University of Basel’s Science Slam and still enjoys making the fascination of his subject area more accessible to non-scientists in an entertaining way.

In the invitation to the defense of his doctoral dissertation in June 2017, Tomaž wrote to the SNI’s management team: “The SNI PhD School proves not only that there is ‘plenty of room at the bottom’ but also that SNI students are able to fill this space with new ideas and materials.” Tomaž Einfalt himself is an excellent example of how this can be done.

Perfect timing paves the way for a dream job

Michael Gerspach is starting his career at BÜHLMANN Laboratories AG

Michael Gerspach was one of the SNI PhD School's first doctoral students and was, for many years, a reliable contact for the Swiss Nanoscience Institute when it came to outreach activities. A few days after defending his doctoral thesis on nanofluidic platforms, he was offered a permanent position as a research scientist at BÜHLMANN Laboratories AG in Schönenbuch. There, in collaboration with three colleagues, he is setting up a group to develop new technologies for medical diagnostics based on biomarkers.

It all began with glass and silicon
Michael Gerspach studied nanosciences at the University of Basel before beginning his doctoral dissertation on nanofluidic platforms for the analysis of individual nanoparticles in 2013. In the early days of his doctoral research, he spent many hours in the clean rooms at the Paul Scherrer Institute, attempting to apply a grid of tiny channels and pockets to glass and silicon chips. Due to electrostatic forces, charged nanoparticles can be stably captured and studied between the negatively charged walls of these channels. Michael optimized the method until he could isolate individual gold particles – measuring just 40 nanometers across – inside the channels for a period of several minutes in order to study them. Although the system worked excellently, it is expensive, time-consuming and requires access to clean rooms.

Cost-effective version
To develop a more cost-effective alternative that can also be used in laboratories without high-tech equipment, Michael Gerspach then focused his efforts on a platform made of polydimethylsiloxane (PDMS). In this case, the clean room is only needed to produce a casting mold and a punch. First, electron-beam lithography and ion etching are used to produce

"The outreach activities taught me to explain my research. I think that also helped during the application process."

Dr. Michael Gerspach
Research scientist at BÜHLMANN Laboratories AG

a silicon model of the platform. With the help of this model, a punch is produced that can then be used to transfer the desired depressions to PDMS. "The first two steps are quite complex, but then the PDMS platform can actually be produced in a completely normal laboratory," says Michael Gerspach in relation to the technique he developed, which allows tiny individual nanoparticles to be captured without any marking or external forces and made available for examination.

Outstanding employer

Michael carried out most of the practical work in the laboratories of the Paul Scherrer Institute (PSI), where he was supervised by Dr. Yasin Ekinci. There, he always found people ready to offer advice and assistance on all matters, both large and small. "The PSI is a great place to work, with excellent equipment and extremely helpful colleagues," he says in our interview. At the University of Basel, Michael received intensive support from Dr. Thomas Pfohl in particular, who was always on hand to discuss matters and to offer suggestions.

Various criteria tipped the scales

By January 2017, Michael had already begun looking for potential jobs for the time after his thesis. There were a number of positions that sounded interesting and a few that matched his profile perfectly. For example, the private company BÜHLMANN Laboratories AG in Schönenbuch, which specializes in medical diagnostics. They were looking for a research scientist to develop and optimize new detection methods for biomarkers as part of an interdisciplinary team. Michael felt this was an ideal position for him and applied. He was invited to several rounds of interviews and was offered the job the week after he defended his thesis. The topic of biomarkers is not entirely new to him, as he had already studied a biomarker for HIV as part of his master's project at the London Centre for Nanotechnology. "That probably also tipped the scales in terms of getting me the job," Michael says.

The company's owner, Dr. Roland Bühlmann, made the decision to hire Michael Gerspach personally: "We were impressed by Michael's specific training in the nanosciences, as well as his expertise and his personality, and we're delighted to have him on board," he says.

There is no doubt that the breadth of training during his degree and at the PhD school have helped him stand out from the other candidates. In addition, he is sure to have earned plus points for his open nature and the SNI activities he took part in outside of his scientific work. For example, in recent years Michael has been involved in organizing three instalments of INASCON, an international conference held by and for nanoscience students. He began by assembling a team in 2015, with whom he then planned and executed a perfect conference in Basel. "It was a lot of fun, and we all learned a great deal. Beforehand, no one had any idea how difficult it is to obtain sponsors, for example, or to run an advertising campaign," Michael recalls. Likewise, the many outreach activities in which he brought nanosciences research to life for a wide variety of groups are also bound to have given him an advantage over the numerous other candidates.

Much to learn and plenty to research

His first task at BÜHLMANN Laboratories is now to set up a new laboratory. Accordingly, Michael Gerspach has spent most of the first few weeks reading up on the subject matter, getting to know his new colleagues, and planning and ordering equipment for the new workplace.

Early 2018 will then see the research start in earnest. The four-person team will study a variety of biomarkers that are expected to provide important information regarding intestinal diseases. Established as a corporate research lab, the new group is to test innovative approaches and to adopt the role of 'think tank' at the company.

When he began his job search, Michael expected to find something a bit more straightforward, but he is now exactly where he wanted to be. "It's great to be setting something up here, to be on board from the outset, and then to research a topic that can benefit so many people. My aim was always to stay in research – but to work in an applied field in industry on a long-term basis," he says.

For the SNI, it is great to see that those leaving the SNI PhD School have such good opportunities on today's highly competitive labor market, and also that industry values their broad, interdisciplinary training.

The SNI PhD School in brief

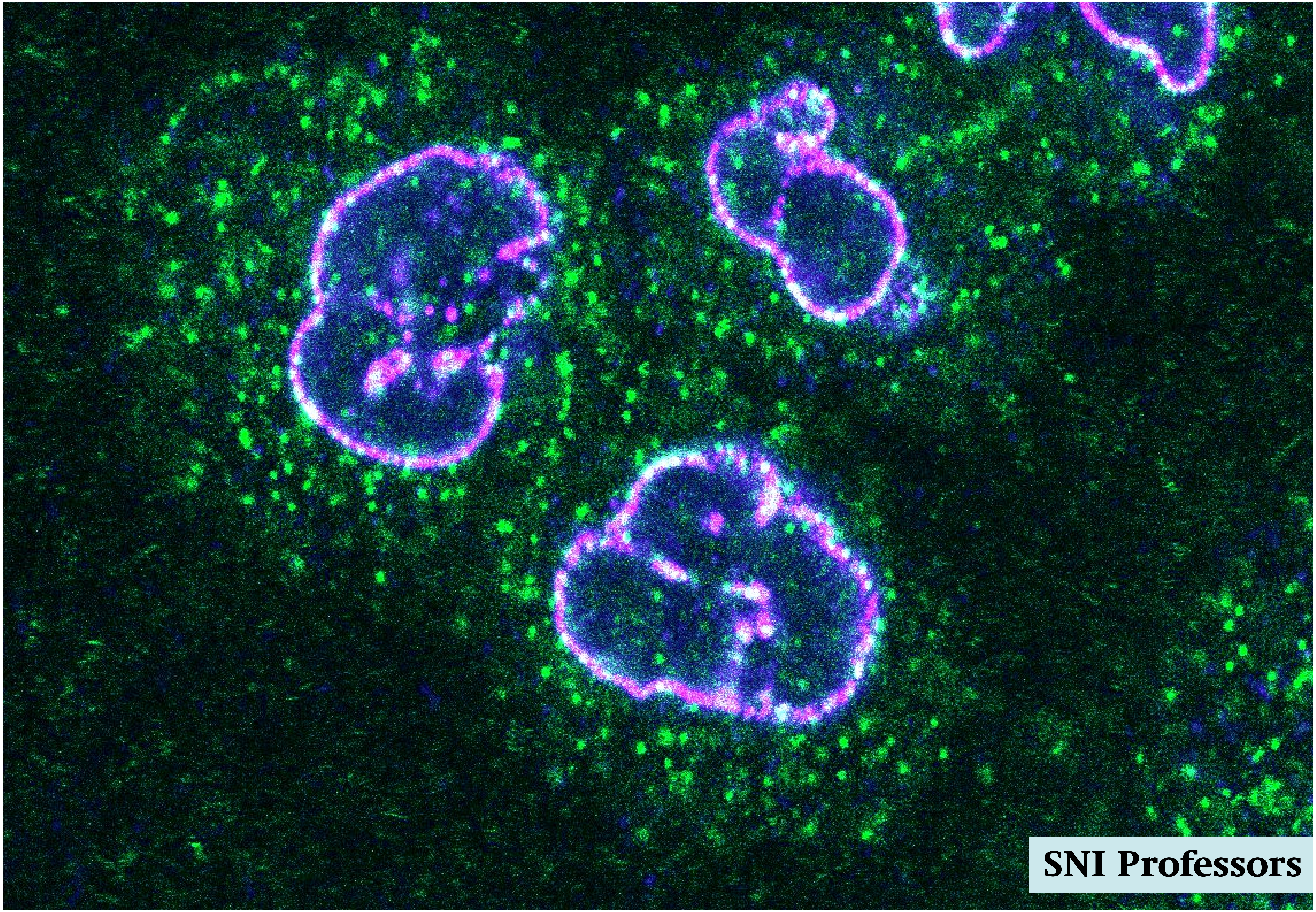
In 2012, the Swiss Nanoscience Institute founded a PhD school to further the training of young scientists. The first doctoral students started in 2013, and 10 of them had successfully completed their PhDs by the end of 2017. They are now continuing their research as postdocs in academia (University of Basel and University of Tokyo) or have taken jobs with various industrial companies (Axetris AG, BÜHLMANN Laboratories AG, Lifeware AG, Kistler Group, Sensirion AG). In 2017, there were a total of 42 doctoral students enrolled at the SNI PhD School. Seven new projects for doctoral dissertations were approved at the end of the year and will begin in 2018.

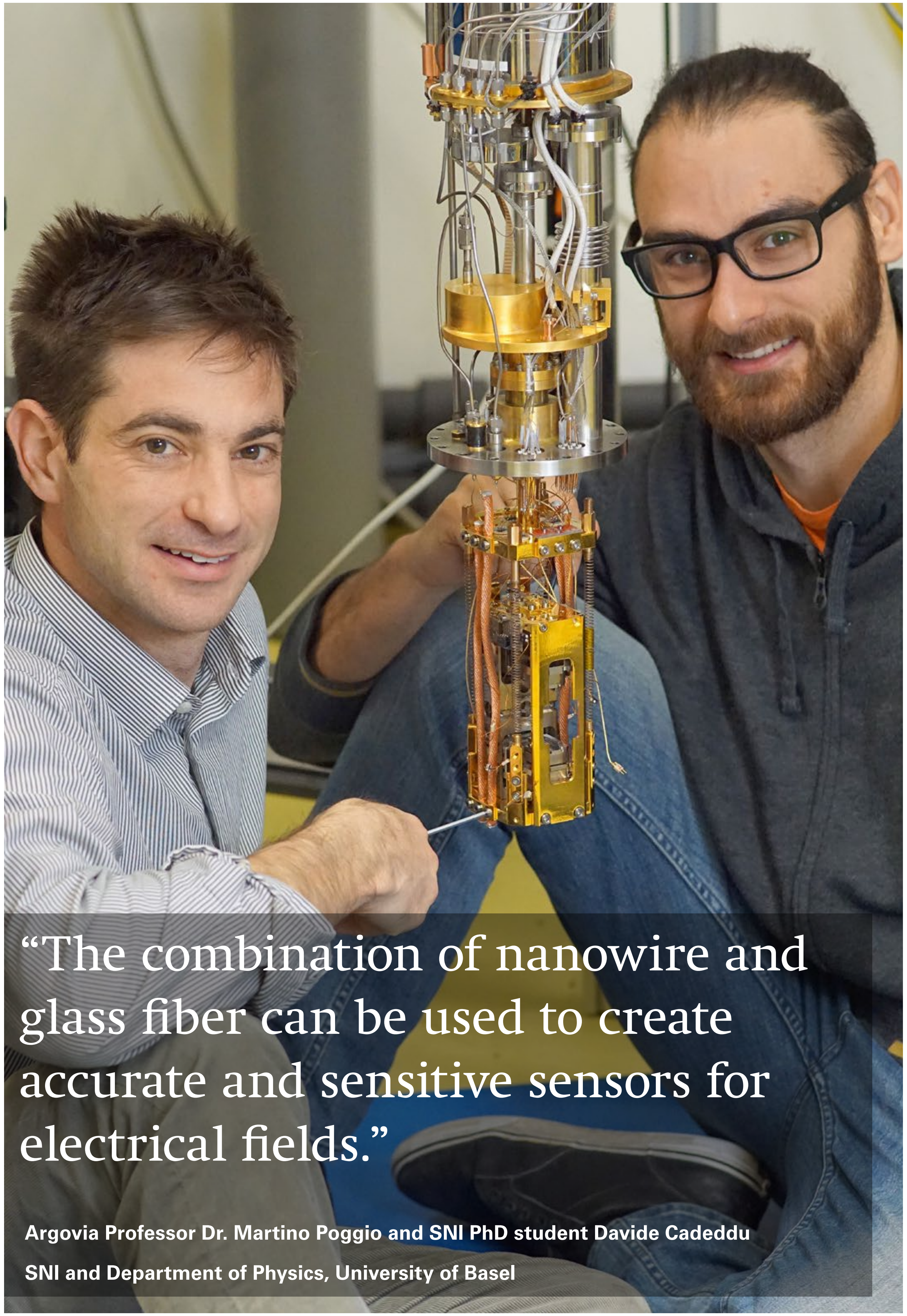
All PhD students are funded by the SNI and supervised by two scientists from the SNI network. At present, the Department of Physics, Department of Chemistry, Biozentrum, and Department of Pharmaceutical Sciences at the University of Basel are actively involved in the SNI PhD School, as are its partner institutions the University of Applied Sciences Northwestern Switzerland (FHNW), the Paul Scherrer Institute (PSI), and the Department of Biosystems Science and Engineering at the Federal Institute of Technology (ETH) Zurich in Basel (D-BSSE).

Dr. Andreas Baumgartner, a physicist, has been responsible for coordinating the SNI's PhD program since early 2017. Baumgartner, who is setting up a research group of his own in Professor Christian Schönenberger's team, has a long-term plan to further intensify and optimize the exchange of ideas between the various disciplines at the SNI PhD School.

This exchange takes place primarily during the various courses and activities that the SNI provides for its doctoral students. At the start of 2017, the Winter School 'Nano in the Snow' was held in Zermatt and prompted the young scientists to engage in lively discussions about their research in an informal setting. In the 'Rhetoric and Communication' course in May 2017, the young doctoral students learned a great deal about presentation techniques and received coaching to develop their personal style. By completing numerous exercises, they also learned that clear examples are an important tool for making complex topics more accessible to the audience.

The doctoral students had a chance to put what they had learned into practice at the Annual Event in September 2017. Held every year in Lenzerheide, this two-day conference provides doctoral students with a perfect opportunity to present their own research, as well as to establish and strengthen contacts with members from across the network.


SNI Professors



"The combination of nanowire and glass fiber can be used to create accurate and sensitive sensors for electrical fields."

Argovia Professor Dr. Martino Poggio and SNI PhD student Davide Cadeddu

SNI and Department of Physics, University of Basel

Nanowires for various applications

The Poggio team wants to create images of electric and magnetic fields with unprecedented accuracy

Argovia Professor Martino Poggio and his team are creating precise images of electric and magnetic fields using tiny nanowires as sensors. In 2017, his SNI doctoral student Davide Cadeddu managed to integrate a nanowire mounted on a glass fiber into a scanning probe microscope, allowing him to produce a highly accurate and sensitive image of an electric field on the nanometer scale. The group also made progress with the imaging of magnetic fields by combining nanowires with tiny magnets. These magnets respond extremely sensitively to miniscule changes in surrounding magnetic fields.

Tiny and almost faultless

Martino Poggio has been studying nanowires for a number of years with a view to developing sensitive new sensors for electric and magnetic fields. For this, he uses not only nanowires that self-assemble from their molecular constituents but also those that are etched or milled out of solid blocks of material. All of these nanowires are characterized by an almost faultless crystal lattice and have a large surface area with respect to their volume, as well as a very low mass.

A source of individual photons

Davide Cadeddu, an SNI doctoral student in Poggio's team, had already managed to produce a very pure source of quantum light using nanowires some time ago, working with colleagues from Professor Richard Warburton's group. To do this, the scientists incorporated individual quantum dots at the tip of a short, pointed nanowire. These so-called 'photonic trumpets' are etched out of a block of gallium arsenide by colleagues from the University of Grenoble and have an approximate diameter of just 200 nanometers at the tip. The team of researchers then skillfully positioned these trumpets in the middle of the open end of a single glass fiber. Even without special functionalization, the quantum dots at the tip of the trumpet emitted individual particles of light (photons). The team had therefore created an easy-to-operate source of individual photons. "We were certain that this nanowire and glass fiber combination offered huge potential and could be used, for example, as a scanning probe for electric fields," says Martino Poggio.

A new type of probe for microscopy

That is precisely what Poggio's team managed to do in mid 2017*. As part of his doctoral dissertation at the SNI PhD School, Davide Cadeddu successfully integrated the

* Physical Review Applied 8, 031002 (2017)]

nanowire and glass fiber combination – known as a 'fiber pigtail' – into a scanning probe microscope. In the experimental setup, the individual photons emitted by the nanowire's quantum dots are passed through the nanowire and the glass fiber and analyzed using a camera. To create a high-resolution image of an electric field, the 'pigtail' is moved towards the sample until it is just a few nanometers away. The sample's electric field causes changes in the energy state of the quantum dots and therefore a change in the color of the emitted light. These variations in the wavelength of the emitted light are dependent on the strength of the electric field and, once recorded, they can be used to draw specific conclusions about the sample's electric field. The result is a detailed, computed image of the electric field with 100-nanometer resolution.

Although the work was a success, Martino Poggio now has more ideas about how to optimize the results. "We know how we can improve the sensitivity further so that the pigtail can be used to detect the charging dynamics, for example, or individual tunneling effects in systems with just a few electrons," says Martino Poggio.

Nanowires in magnetic force microscopy

Nanowires are not only suitable for producing precise images of electric fields, but can also be used to study extremely small magnetic fields. In another project, for example, Poggio's team are busy producing self-assembling gallium arsenide nanowires and fitting them with magnetic tips. "We're in the process of applying nanowires to magnetic force microscopy (MFM)," Martino Poggio explains. "Instead of the large cantilever probes this technique normally uses, we want to use nanowires that are 10 to 100 times smaller and have a tiny magnet at the tip," he adds.

Like the cantilever probe in classical magnetic force microscopy, the nanowire reacts to the sample's magnetic fields by changing its vibration, which can be measured precisely. However, as the magnet at the tip of wire has its own magnetic field, and as this exerts an influence on the sample, this approach is significantly harder to implement than it initially sounds to the non-expert. Martino Poggio ends the interview with a prediction: "I'm optimistic that, by the time of the next annual report, we'll be able to provide far more detail about this area of our research."

The SNI professors in brief

The Swiss Nanoscience Institute has supported the two Argovia professors Roderick Lim and Martino Poggio since they began their work at the SNI. Roderick Lim and his team focus on nuclear pore complexes in biological membranes in order to study how metabolic transport between the nucleus and the cytoplasm functions. Martino Poggio focuses his research on nanomechanics and nanomagnetism. Among other topics, he and his group study nanowires and especially their application as multifunctional sensors.

In 2017, Lim and Poggio made their research findings public via 14 articles in established scientific journals and in the context of numerous talks given by them or members of their research group at various national and international conferences. In addition to the funding Lim and Poggio receive from the SNI, they have together managed to attract almost 1.6 million Swiss francs in external funding for their research.

The SNI also supports the work of the three SNI-funded titular professors Thomas Jung, Michel Kenzelmann, and Frithjof Nolting. All three teach in the Department of Physics at the University of Basel and lead research groups at the Paul Scherrer Institute. Thomas Jung is also responsible for the Nanolab in the Department of Physics at the University of Basel.

Cooperating proteins

Argovia Professor Roderick Lim is gaining an ever clearer understanding of active transport through nuclear pore complexes

For a number of years, Roderick Lim and his team have been investigating how pores in the nuclear envelope regulate selective transport of larger molecules between the cell nucleus and the cytoplasm. Their latest results show that two different import proteins act as gatekeepers and ensure continuous transport through the pore. This finding challenges the prevailing assumption so far that a molecular filter is the sole barrier in this process. Roderick Lim likens the system to a revolving door.

The cell's control room

Cells of higher organisms are divided into many different areas in which a range of processes take place. One such compartment is the cell nucleus, which contains a large portion of the cell's genetic information. The cell nucleus is not just where the genetic information is stored, but also where it is replicated and transcribed. Genetic information is transcribed into transportable messenger RNA, which subsequently provides the information needed for protein synthesis in the cell's ribosomes. The cell nucleus is also where the subunits of these tiny protein factories are produced.

Selective, active transport processes

All of the building blocks needed for the various processes inside the cell nucleus must find their way there from the surrounding cytoplasm. This involves passing through the protective nuclear envelope. This traffic occurs through pores in the nuclear envelope. These pores are not simply holes in the nuclear membrane, but complex filter systems that employ an ingenious transport system to regulate the exchange of compounds between the cell nucleus and the surrounding cytoplasm. Water and smaller molecules can pass through this barrier unhindered thanks to diffusion. However, larger molecules – such as proteins – must bind to import proteins (importins) to be transported against a concentration gradient through the pores. Only molecules marked with specific signals known as nuclear localization signals are able to bind to importins.

The latest research by Lim's team has now shown that two different import proteins work hand in hand to regularly open and close the pores in much the same way as a revolving door. Importin alpha recognizes the nuclear localization signal and uses it to determine which cargo can be transported into the cell nucleus. It acts as a molecular switch, supporting the formation of importin beta, which in turn grants the cargo access to the pore by means of binding. Importin beta binds to the binding sites of the nucleoporins, or FG Nups, tethered inside the nuclear pore complex. By shuttling back and forth within the pore, importin beta allows bound molecules to pass through it – opening the revolving door to the cell nucleus, as it were. A Ran guanosine triphosphate gradient between the cytoplasm and the inside of the cell nucleus supplies the energy needed to operate the revolving door.

“We gained a better understanding of the factors that regulate the active transport of large molecules in and out of the nucleus.“

Argovia Professor Dr. Roderick Lim

SNI and Biozentrum, University of Basel

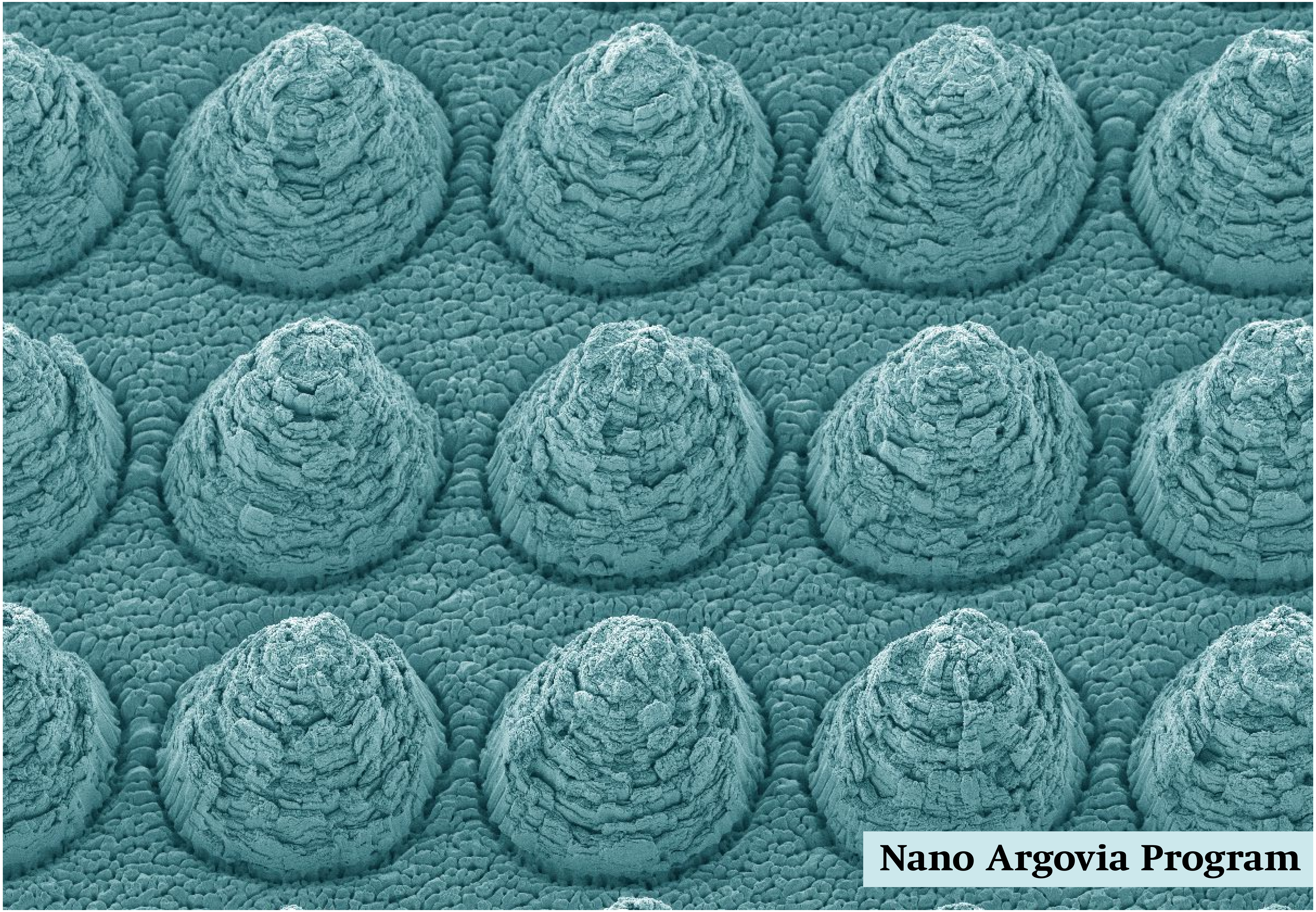
Interaction between importins

The nucleoporins that line nuclear pores were previously thought to be solely responsible for selective active transport. However, the new findings show that this filter is not a sufficient barrier in itself. Rather, it is the interaction between importins, operating in tandem with the nuclear pore complexes, that ensures selectivity.

When importin alpha is scarce, Lim’s team demonstrated that importin beta blocks the revolving door and inhibits the transport of proteins into the nucleus. And under conditions where importin beta is insufficient, the pore’s barrier function is impaired. This reduces transport selectivity, allowing unwanted compounds to enter the cell nucleus. Adding importin beta nullifies this effect.

Besides contributing to a general understanding of how nuclear pore complexes work, the research by Roderick Lim’s team, published in the Journal of Cell Biology*, offers clues to the causes of defective protein transport, which can lead to illnesses such as cancer. “We now have a much better understanding of the factors that regulate active transport of larger molecules such as proteins into and out of the cell nucleus,” said Roderick Lim, commenting on his team’s work.

* Journal of Cell Biology, 216 (11), 3609-3624


Nano Argovia Program

Faster analysis with tiny quantities

MiPIS Argovia project optimizes sample preparation for cryo-electron microscopy

In 2017, the Nobel Prize in Chemistry was awarded to Professor Jacques Dubochet, Professor Joachim Frank, and Professor Richard Henderson. They received the prestigious science prize for the development of cryo-electron microscopy (cryo-EM). Thanks to this method, it is now possible to create 3D images of complex proteins in their natural environment at atomic resolution. Cryo-EM has become an established standard for protein analysis and has revolutionized structural biology and biochemistry. However, existing methods of protein isolation and preparation are not necessarily geared toward the needs of cryo-EM. In the MiPIS Argovia project, therefore, an interdisciplinary team led by Dr. Thomas Braun (C-CINA, Biozentrum) is working to develop an ideal, rapid, microfluidic technique. The scientists aim to have protein samples cleaned, stabilized, and prepared for cryo-EM analysis within two hours while preserving their three-dimensional structure.

Cryo-EM has been the method of choice for years

For many years, the cryo-electron microscope (cryo-EM) has been at the heart of research by Professor Henning Stahlberg and Dr. Thomas Braun from the Center for Cellular Imaging and Nano Analytics (C-CINA), which is operated by the University of Basel's Biozentrum. Together with their teams, the scientists have focused on studying the molecular mechanisms behind the development of neurodegenerative diseases and on characterizing membrane proteins. They use a variety of imaging techniques in their work. Today, thanks to cryo-EM in particular, the researchers are able to generate precise images of the three-dimensional arrangement of complex proteins at atomic resolution. These detailed images are the first step toward understanding diseases and identifying potential targets for active pharmaceutical ingredients.

Adjustments needed

However, the classic methods of preparing proteins are not always appropriate for the requirements of cryo-EM because they are time-consuming, involve relatively large quantities of protein, and partly disrupt the spatial arrangement of the protein complexes. To simplify and improve the analysis of proteins, the scientists from C-CINA are therefore also developing new methods of isolating and processing proteins, which can then be analyzed using cryo-EM.

As the identification of proteins' three-dimensional structures only requires cryo-EM images of between 100,000 and a few million protein particles, the scientists in the MiPIS Argovia project are focusing on microfluidic systems, which they hope will deliver significant advantages over the classic methods. A microfluidic system has

"The Nano Argovia program is the ideal platform for collaborating with industry partners."

Claudio Schmidli and Luca Rima

PhD students at C-CINA, Biozentrum University of Basel, and members of the Nano Argovia MiPIS project

already been developed at C-CINA as part of other SNI projects. This system requires just a few nanoliters of sample material, which is placed directly on one of the slides used for electron microscopy in a fully automated process. In the MiPIS Argovia project, the aim is now to refine this system so that it can clean, stabilize, and prepare proteins for cryo-EM analysis within two hours while preserving their three-dimensional structure. Alongside project leader Dr. Thomas Braun, those involved in the work include Dr. Mohamed Chami from the BioEM Lab (C-CINA), Professor Marianne Hürzeler from the School of Life Sciences at the University of Applied Sciences Northwestern Switzerland (FHNW), and Professor Michael Hennig and Dr. Mathieu Botte from the start-up leadXpro (Villigen, Aargau).

Held in place with magnets

"We've managed to expand our existing platform so that we now have a quick and reliable method at our disposal," says Thomas Braun. In order to isolate proteins from an untreated cell lysate, the first step in the process is to functionalize superparamagnetic particles with antibodies that bind to the protein being analyzed. When these particles are mixed with the cell lysate, the proteins bind to the antibodies and are therefore connected to the tiny magnetic particles. In a microcapillary, the proteins can then be immobilized using a magnet, separated from other components of the cell lysate, and washed. Using UV light, the proteins are then disconnected from the paramagnetic particles and the antibodies bound to them and are 'written' directly onto the slide with the microcapillary.

Now, a special electron microscope slide is covered with a perforated carbon film and placed on a platform whose temperature is kept near dew point. The microcapillary used to clean the protein sample is placed above the slide. A few nanoliters of the suspension are applied to the slide, and the platform is moved slightly in order to distribute the sample evenly. While the microcapillary is removed from the slide, the sample remains on the temperature-controlled platform for a short time and is concentrated in a controlled manner via evaporation. The scientists then quickly plunge the slide, along with the applied sample, into liquid ethane. This rapid freezing process causes the water present in the sample to solidify into amorphous ice and therefore to exhibit glass-like properties. This process does not produce crystals, which would destroy the protein structure. Known as vitrification, this step in the cryo-electron microscopy technique was developed by Swiss Professor Jacques Dubochet, who was awarded a Nobel Prize for this groundbreaking innovation.

The whole sample preparation process takes place automatically and requires only around 3 to 15 nanoliters of liquid, whereas conventional methods operate with sample volumes of 3 to 5 microliters. With conventional methods, it generally takes scientists several days to obtain cleaned proteins from the cell lysate and prepare them for cryo-EM analysis. The team behind the MiPIS Nano Argovia project now achieves this in under two hours thanks to the new microfluidic system.

"We've managed to develop an almost lossless method," says Thomas Braun. "Whereas, in classic preparation methods, far larger quantities of proteins are required and the majority of the sample is lost, we just need small sample volumes. Moreover, the proteins are only exposed to air for a very short time, which prevents damage due to drying."

The Nano Argovia program in brief

The Nano Argovia program bridges the gap between basic scientific research at the SNI and its industrial applications. Each Nano Argovia project pairs at least two academic partners from the SNI network with an industrial company from Northwestern Switzerland. The team spends one year examining the feasibility of various nanotechnology approaches, which are derived from research conducted at the SNI and provide companies in Northwestern Switzerland with interesting opportunities for innovation.

In 2017, 13 Argovia projects received total funding of around 1.3 million Swiss francs. Of these 13 projects, three had been extended on a cost-neutral basis. Nine projects (69%) were conducted in cooperation with companies from the Canton of Aargau.

In 2017, the Nano Argovia program led to a total of 33 publications, one patent, and the submission of four patent applications, one of which relates to an existing patent that has now been applied for at EU level.

Individually adapted and stable

The goal of the Nano Argovia project CerInk is to develop custom-made bone replacement materials that closely resemble natural bone

Humans have over 200 different bones with varying shapes, each of which performs a specific, important function in the body. In the event of bone defects due to accidents, inflammation, or tumors, it is possible to replace the damaged bone – or parts of it – with artificial bone. Given the considerable variations between individual patients and bone types, 3D printing seems the obvious method for producing customized replacement bones. However, optimum bone replacement materials must meet a series of demanding requirements. They must be long-lasting and well tolerated by patients. In addition, they should be lightweight and yet mechanically stable – in other words, they should resemble natural bone as closely as possible. As part of the Nano Argovia project CerInk, scientists from the FHNW School of Life Sciences, the Paul Scherrer Institute (PSI), and the Aargau-based company Medicoat AG worked together closely to develop future bone replacement materials of this kind.

Layers with different properties

Human bones are not homogeneous. Rather, they are characterized by a solid outer surface with a dense, mechanically stable (cortical) bone structure, in combination with an internal, sponge-like (trabecular) structure that acts as a sort of shock absorber. The size of these different layers varies depending on the type of bone. This type of multi-layered structure is also desirable in artificial bones that are implanted into patients following accidents or injuries. Scientists from the FHNW School of Life Sciences, the PSI, and the Aargau-based company Medicoat AG have already gained valuable experience in the field of innovative bone replacement materials and have previously combined bioceramic materials with polymers to imitate natural bones using 3D printing. Now, as part of the Nano Argovia project CerInk, they have investigated how the printing process can be used to produce compacted layers with improved mechanical stability. To do so, the scientists added ceramic nanoparticles (nano ink) to the base material. In a subsequent sintering process (which consolidates the artificial bone at high temperature), the nanoparticles bring about a change in density.

Twenty percent is not enough

The team, initially led by Ralf Schumacher (formerly of the FHNW) and later by Dr. Andrea Testino (PSI), used calcium phosphate – the major inorganic component of natural bones – as a scaffolding material for the synthetic bones. They first tested various nano inks with different concentrations of calcium phosphate nanoparticles and biocompatible sintering aids. After some time, it became clear from the experiments that standard print heads can only be used in the 3D printing process if the nano ink contains no more than 20% calcium phosphate nanoparticles. However, this would not allow them to increase the density of the base material to the desired level.

Potato starch to form pores

In the second year of the project, the scientists therefore adopted a different strategy. To find out which nano ink was the most suitable additive, they produced sample pieces from various combinations of materials – without a printing process. This involved combining a calcium phosphate matrix with potato starch, whose purpose was to form pores and to act as a binder. The base materials were ground, dried, and mixed with differing quantities of calcium phosphate nanoparticles, bioglass, and colloidal silica. These sintering aids support the differentiation and multiplication of osteoblasts in the finished bone implant. Finally, the scientists pressed these mixtures into a casting mold. In the first heat-treatment step, they burned the potato starch to create a porous material with the desired initial density. In the subsequent sintering process, the researchers tested three different temperatures between 1,350°C and 1,450°C. In total, they were left with almost 150 different samples, whose mechanical properties and density they analyzed.

A successful approach

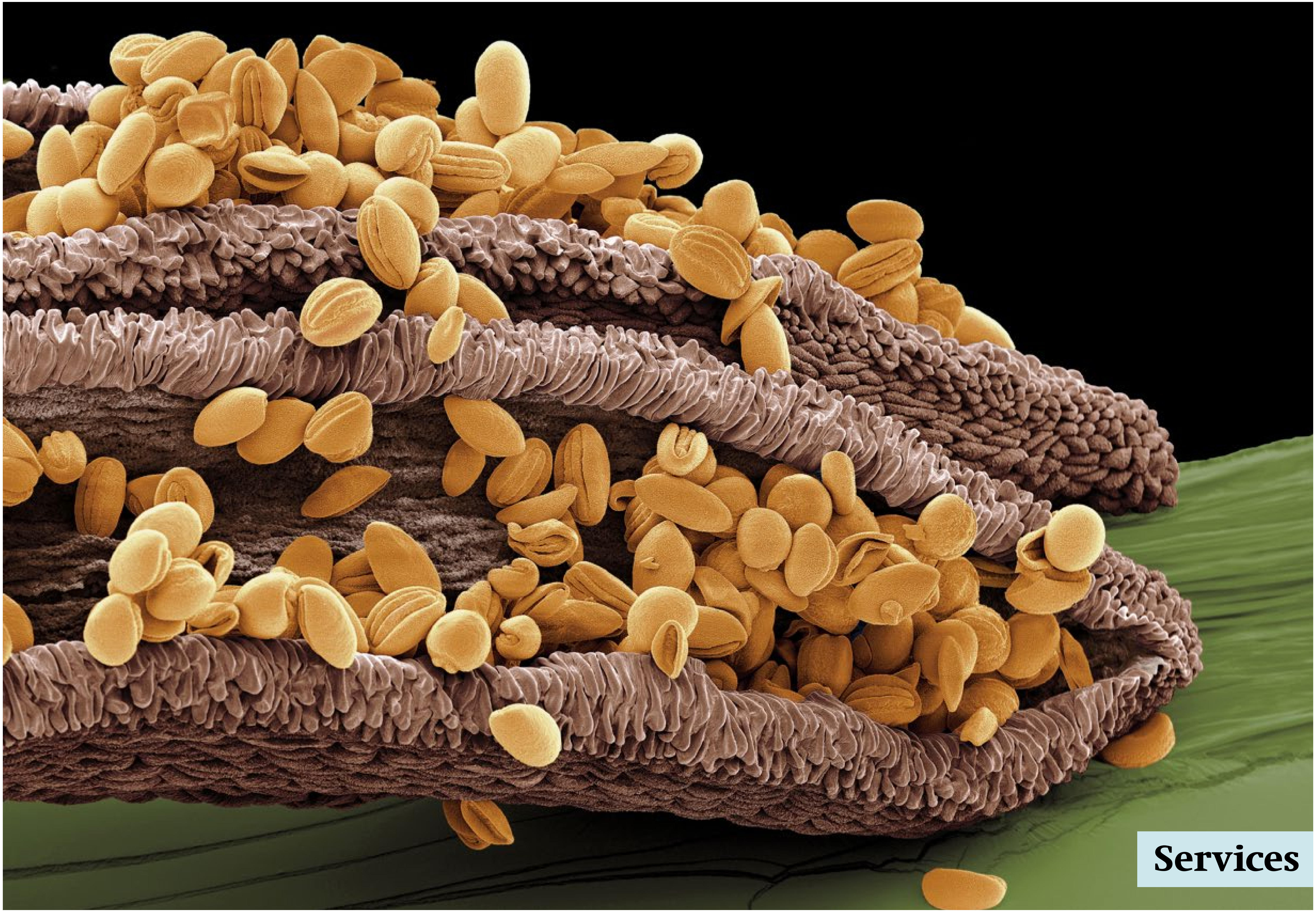
The scientists then combined two layers of materials with different composition, carefully selected among more than 5,000 possibilities, to find out how stable the boundary was between the two materials after sintering. As a result, the most suitable combinations, in terms of sintering behavior, density, and mechanical stability for modern bone replacement materials, were identified. Based on morphological analyses using both optical and electron scanning microscopes, the team of researchers established that the chosen approach is promising and could be used to bond two layers together firmly even if they have different densities and mechanical properties.

“In the Nano Argovia project CerInk, we showed that we can produce bone replacement materials that closely resemble natural bone,” says Andrea Testino, the project leader. “In our tests, we were able to produce synthetic bone whose properties correspond to the spongy trabecular structure of bone on one hand and the more-stable cortical structure of bone on the other.” Philipp Gruner, CEO of the industrial partner, Medicoat, also considers the completed Nano Argovia project a success: “Thanks to our project partners’ expertise in this outstanding collaboration, we are in a position to break new ground and develop truly innovative products and technologies for the benefit of patients.”

“The Nano Argovia program offers the chance to learn from specialists in research as well as from experts in the partner companies.”

Agnese Carino

PhD student at the Paul Scherrer Institute and member of the Nano Argovia CerInk project



Services

Searching for clues with a microscope

The SNI's Nano Imaging Lab analyzes surfaces of all kinds

The Nano Imaging Lab (NI Lab) operated by the Swiss Nanoscience Institute (SNI) provides comprehensive surface imaging and analysis services to both internal and external customers from science and industry. Led by Dr. Markus Dürrenberger, the five-person team provides customers with tailored advice and conducts a wide range of measurements and analyses as required. In 2017, the NI Lab's detailed imaging and analyses provided answers to highly specific questions in projects carried out with, for example, the Swiss Gemmological Institute, the Department of Physics at the University of Basel, and the Natural History Museum in Basel.

Analysis of precious stones

The Swiss Gemmological Institute (SSEF) has been a customer of the SNI's Nano Imaging Lab for many years. Above all, the researchers are interested in scanning electron microscope (SEM) images and the rapid chemical analysis of elements using energy-dispersive X-ray spectroscopy (EDX). These techniques allow the scientists to identify inclusions in gemstones, for example, or to visualize structures on the surface of pearls. The NI Lab regularly analyzes specific gemstones – this information can be used to determine their origin, a vital piece of information in the trade.

In addition, the SSEF visits the lab each year to demonstrate the various applications of SEM technology to five or six scientists from around the world who are attending its Scientific Gemmology Course. "The course participants are already well trained, but the NI Lab gives them an opportunity to see many more applications on the SEM in a shorter time than is possible in their own professional environment," explains Professor Henry A. Hänni, former director of SSEF, who has been working with the NI Lab's predecessor organizations since the 1970s.

In 2017, the NI Lab's Evi Bieler also supervised an SSEF student who is studying rubies and spinels from Myanmar as part of her doctoral thesis in order to gain a

"Using our images, we can prove whether cracks in gems are filled with glass."

Evi Bieler

Nano Imaging Lab, Swiss Nanoscience Institute, University of Basel

better understanding of the formation of the world's only gemstone deposit of its kind. With the NI Lab's support, Myint Myat Phyo – the doctoral student – was able to identify numerous mineral inclusions in ruby and spinel using scanning electron microscopy in combination with X-ray analysis. She is now working on a publication about this work. The successful collaboration with the NI Lab is summarized by PD Dr. Michael S. Krzemnicki, director of SSEF: "The NI Lab and its proven expertise are very important to us, not only in the context of this research project, but also because they allow us to analyze and visualize gemstone-specific questions such as vapor deposition, crack-filling with glass, and pearl growth."

Tackling inflammation with structured surfaces

In another example of how images have led to key research findings, the NI Lab is working with a group of researchers from the Department of Physics, the University Center for Dental Medicine at the University of Basel, and the FHNW School of Life Sciences. In this project, the scientists are investigating whether the structuring of titanium surfaces in dental implants can be used to reduce bacterial colonization while simultaneously aiding the adhesion of human tissue cells.

Turning to nature for inspiration, the scientists have found a model for this bactericidal effect on the wings of cicadas, for example. The wings have a structured surface covered with numerous nanoscale columns, to which bacteria adhere excellently. However, the bacteria's cell membrane is destroyed by a purely mechanical effect, causing the bacteria to die.

In an interdisciplinary project, the researchers are able to treat the implant's titanium surface with plasma to produce a structure resembling that of the cicada's wing. They can also vary the size of the needle-like columns. Detailed scanning electron microscope images produced by the NI Lab revealed the differences in the structure, as well as proving that bacteria adhere to the columns and become deformed. However, microbiological analyses showed that the bacteria are no longer able to reproduce. "The NI Lab's images also show that larger columns not only perforate bacteria but also damage the human tissue cells," says Dr. Laurent Marot of the Department of Physics, who is responsible for the process of structuring the surfaces. Summing up the project's prospects for the future, Marot says: "We're very confident that an optimized structure can be used to create a bactericidal effect and aid the multiplication of human tissue cells."

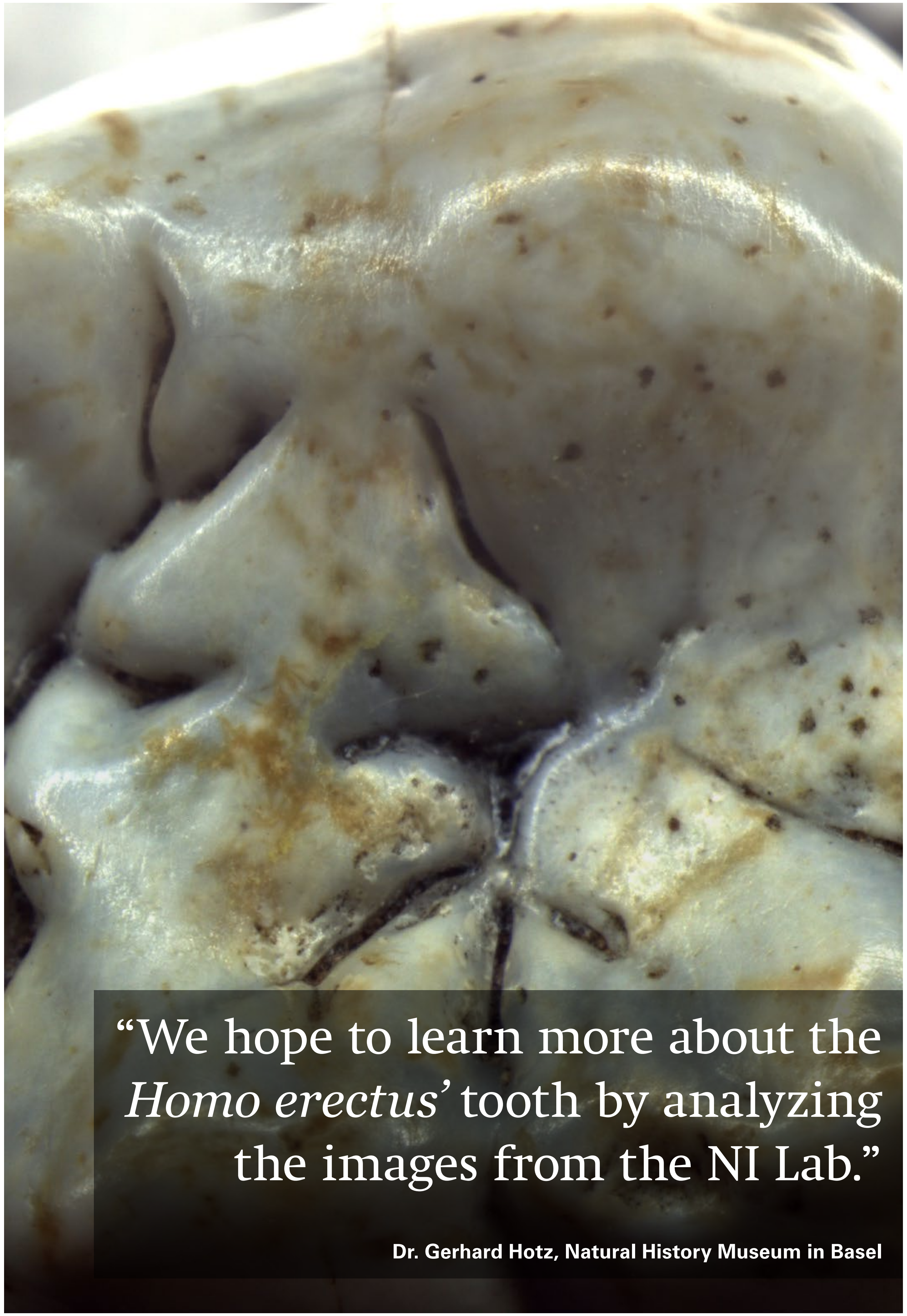
On the trail of eating habits

Another exciting project also got underway in 2017. The curator of the Natural History Museum in Basel, Dr. Gerhard Hotz, contacted Markus Dürrenberger and asked for his help to analyze a tooth. However, this was no ordinary tooth, but one from a *Homo erectus* thought to have lived in Indonesia around a million years ago.

The tooth is being studied by Philipp Smoliga of the University of Basel's Institute for Integrative Prehistory and Archaeological Science (IPAS) as part of his master's thesis under the supervision of Gerhard Hotz. Smoliga is writing about Professor Roland Bay, a scientist from the dental hospital who died in 1992. Over his lifetime, Bay collected around 100 teeth, which became the property of the Natural History Museum in Basel following his death. The fossilized tooth from *Homo erectus* is something of a crown jewel in Bay's collection, and is therefore central to Smoliga's thesis. On the one hand, he is addressing how the tooth came to be in Basel in the first place; on the other hand, the scientists are also hoping to discover new information about *Homo erectus*.

This is where the Nano Imaging Lab comes in. Based on microscopic analyses of the tooth's surface, the specialists hope to learn more about the diet of *Homo erectus*. In order to do this, they are analyzing signs of wear found on the tooth, which is otherwise very well preserved.

The NI Lab team has now conducted an initial analysis of the tooth using a confocal microscope and imaged individual areas of interest using a special electron microscopical procedure. Electron microscopy usually involves coating the specimen with a thin conductive film. However, this is not possible for the tooth, as the film cannot be removed afterwards and could therefore result in long-lasting damage to this rare and valuable specimen. Close collaboration and coordination between the project partners is therefore needed to establish how the tooth can be treated. The next few months will perhaps provide an indication of where the tooth comes from, as well as unravelling other secrets surrounding the tooth and its owner, who has been dead for around a million years.



"We hope to learn more about the *Homo erectus'* tooth by analyzing the images from the NI Lab."

Dr. Gerhard Hotz, Natural History Museum in Basel

SNI services in brief

The SNI offers a variety of technology services for internal and external partners from science and industry. In particular, the SNI's Nano Imaging Lab (NI Lab), the technology group, the electronics and mechanics workshops in the Department of Physics consistently develop innovative solutions to a wide range of problems and tasks with their excellent equipment and highly qualified staff.

Since 2016, the Nano Imaging Lab (NI Lab) is part of the SNI. It provides comprehensive surface imaging and analysis services to both internal and external customers from science and industry. Led by Dr. Markus Dürrenberger, the team of five staff provides customers with tailored advice and conducts a wide range of measurements and analyses using electron, scanning electron, scanning probe, and optical microscopy according to the specific requirements. Project partners can also play an active role in long-term projects. They are briefed extensively to enable them to conduct their own analyses using the NI Lab's various electron and scanning probe microscopes. In addition to the services for customers from science and industry, the NI Lab also offers block courses for nanoscience and biology students and consistently receives outstanding feedback for the excellent support it provides.

In 2017, the NI Lab's customers included various working groups from the SNI network, particularly from the University of Basel. External industrial companies such as Glatt GmbH, Rolic Technologies Ltd., Straumann AG, and Würth AG also took advantage of the NI Lab's excellent services in 2017.

Held for the first time in 2017, the NI Lab's User Event was an opportunity for existing and potential customers to gain an overview of the diverse and exciting work performed by the NI Lab's highly experienced team, as well as ideas for future collaborations. The NI Lab publishes a regular newsletter to keep customers and partners updated on current activities, exciting projects, and new equipment.

If you are not a customer yet, you can become a client at: https://nanoimaging1.unibas.ch.

Synchronized light for physicists

An optical fiber network allows the shared use of light sources in various laboratories

The workshops and technology group at the Department of Physics provide key support for the work of SNI members. Many research findings would be impossible without the professional assistance and outstanding range of equipment offered by the various groups. One project that is set to play an important role in the future is the creation of an optical fiber network linking laboratories in Physical Chemistry with those in Physics. With this innovative approach, the participating research groups and the technology group have broken new ground under the group's former head Dr. Peter Reimann and his successor, Dr. Laurent Marot. The network allows various laboratories to share a high-precision laser system and is an excellent example of innovative approaches and the sustainable and effective use of resources.

One device for everyone

Experimental research often goes hand in hand with costly laboratory equipment – and things are no different for the research groups that make up the SNI. Sometimes, however, there are opportunities to share high-tech equipment. One such opportunity came in 2015, when a group of young physics professors at the University of Basel had the idea of sharing a high-precision laser system and therefore of 'lending' laser light from one laboratory to another. The laser system is known as a 'frequency comb' and can be used to generate a precisely defined frequency spectrum. This technology, whose development was honored with a Nobel Prize, can be used to compare the oscillation frequencies of two differently colored lasers. This is not possible with the same precision with other methods because light has an extremely high frequency of 10^{15} oscillations per second.

Linking up for optical experiments

The frequency comb is located in the laboratory of Professor Stefan Willitsch in Physical Chemistry. For the groups led by Professor Philipp Treutlein, Professor Richard Warburton, and Professor Patrick Maletinsky in the Department of Physics – who also work with optical systems – the obvious thing to do was to share the equipment and use it for their own precision measurements. In theory, an optical fiber network could be used to connect the laboratories and therefore not only to share the light from the frequency comb, but also to directly link the laboratories for other optical experiments. "However, no one was quite sure how we could integrate an optical fiber network into an existing building," recalls Philipp Treutlein, one of the project's initiators.

Special requirements

As head of the technology group at the time, Peter Reimann was tasked with drawing up the plans, and it became clear to him that this was a step into the unknown: "Nowadays, the transfer of digital data via optical fibers is an established technique in communication – that much is easy. However, the optical fiber network planned for the physics department had to meet a completely different set of requirements," he says. "The planned measurements require the frequency and phase of the emitted signal to remain constant, and there can be no interference whatsoever. As a result, it quite quickly became clear that the optical fiber cables couldn't simply be pulled into the conduits used for existing cables. This would have left them too prone to problems such as electrical or mechanical interference, especially in the event of subsequent work on the conduits," he adds.

Colored conduits give a better overview

Peter Reimann therefore drew up plans to initially install a network of conduits, which the optical fiber cables would then be pulled into at a later stage. A series of different conduits had to be installed because the research groups wanted to work with various frequencies and because each optical fiber cable can only cover a specific frequency range. The planners therefore opted for colored conduits, each holding a single optical fiber cable, so that it would be clear which conduits contained which fibers even years later.

"Right from the outset, we faced the question of how we would get the optical fiber cables into the conduits," recalls Peter Reimann. The problem was that no mechanical load whatsoever could be applied to the cables, as any damage to the micrometer-thick glass inside could put an end to the planned experiments. "We didn't find anyone who could offer us advice on this," says Peter Reimann. "Even experts were unable to tell us what load we could safely apply to the cables. After all, some of them are up to 50 meters long."

'Fired' into the conduits

The team therefore experimented with a tried-and-tested method: First, a piece of string was attached to a dart, which was then blown through the conduit by applying excess pressure at the near end and negative pressure at the far end. To do this, the technicians attached a vacuum cleaner to the conduit and used air pressure to propel the string into the conduits. The string was then attached to the optical fiber cable so that the two could be blown into the conduit together as gently as possible and by applying only very slight tension. A cushion of compressed air was used in conjunction with the slight vacuum applied at the far end of the conduit, so that the cable was almost floating on the cushion of air. The team tested this method with a number of optical fibers and were able to confirm that the signals retained their high quality even after the optical fibers were inserted, and that they were suitable for the planned experiments.

"We are now able to 'borrow' laser light and to use the frequency comb for our precision measurements," says Philip Treutlein. "However, this innovative optical fiber network also allows us to link up our laboratories for very specific applications." For example, Richard Warburton's group uses semiconducting quantum dots to generate individual photons, while Philipp Treutlein's team has built a memory for individual photons of the same wavelength. Using the optical fiber network, Warburton's team can now 'send' the individual photons to the memory without having to move the experimental setups from one laboratory to the other.

"For groups in the physics department who work with optical systems, this network is a real investment in the future," concludes Philipp Treutlein. The project received an SNSF R'Equip grant and has been implemented by the technology group over the last two years.

Communication & Outreach

“With a simple experiment, we can demonstrate that graphite conducts electricity.”

Dr. Kerstin Beyer-Hans and Dr. Michèle Wegmann, Swiss Nanoscience Institute

Always tailored to the audience

The SNI outreach team customizes activities for various target groups

The SNI believes it is very important to share its fascination with the sciences and take children and young people on thrilling journeys into the nanocosmos. This isn’t always easy – after all, nanoparticles are so small that they cannot be seen with the naked eye. However, the SNI outreach team is constantly working on new interactive approaches to help various target groups understand the possibilities of nanoscience and the topics currently being researched by SNI teams. Read two examples of how this works below.

Interactive children’s program

The SNI’s youngest audience (aged 8–16) can be found at the annual Science Days at Europa-Park in Rust. Over three days, thousands of children and young people flock to Germany’s oldest science festival. In 2017, the spotlight was on the subject of ‘humans’, with 85 exhibitors from Germany and abroad offering hands-on scientific experiences.

Focusing on the atomic force microscope (AFM), the popular SNI stand gave visitors insights into how innovative microscopes are aiding research into human beings and helping to diagnose diseases. The AFM was developed 30 years ago by SNI Vice-Director Professor Christoph Gerber and his colleagues and has been evolving ever since. Today, scientists can use it to film biological nanomachines at work, display chemical bonds, diagnose malignant tumors, and much more. To better demonstrate the principle behind this special microscope, Dr. Kerstin Beyer-Hans of the SNI developed and constructed a wooden assembly kit that visitors could use to make a simple model of an AFM. Around 300 children took part and went home with a demo AFM of their own.

Appealing to young people

The TecDays held at Swiss high schools on the initiative of the Swiss Academy of Engineering Sciences (SATW) allow the SNI team to talk to a slightly older audience (ages 15–19). Professors from the SNI network and the outreach team have been participating in this event for many years to introduce young people to the fascinating world of nanoscience.

In November 2017, Dr. Kerstin Beyer-Hans and Dr. Michèle Wegmann premiered their new program, ‘Big Bang goes Nano’, in the Alte Kantonsschule school in Aarau. The two outreach managers presented entertaining introductions to graphene and protein structure analysis. Their interactive program is based on Sheldon Cooper and Amy Farrah Fowler, two popular characters from the series ‘The Big Bang Theory’. Sheldon, a somewhat odd physicist, focuses on graphene and its particular suitability for conducting electricity, while Amy, a young neuroscientist, explores the protein misfolding that can lead to diseases such as Parkinson’s.

Experiments create an emotional connection

After a theoretical introduction with some appropriate clips from 'The Big Bang Theory', the students sprang into action. Using a simple electricity circuit with a small LED, they saw how well the graphite in a pencil conducts electricity – even across a very thin layer on a sheet of paper. Barbara Lennon, a teacher at the Alte Kantonsschule, commented: "I really enjoyed this module and I will incorporate the graphene experiment into my lessons."

The students were even more impressed by the second part of the program, which allowed them to see for themselves the challenges of living with Parkinson's. A vibrating glove demonstrated, for example, how difficult it suddenly becomes to thread a needle or drink a small glass of water. Weights on their ankles and wrists illustrated the effort it takes to climb stairs or carry shopping. "Before, I didn't really know how hard and stressful it is to live with Parkinson's. I see things in a completely different light," noted one student after removing the glove and weights.

This practical experience will help the students to remember the theory behind the experiments, and may come back to them in a few years when choosing a degree course. "We always let the young people know about the University of Basel's nanoscience degree program. It would of course be great to awaken their interest in our program," explained Kerstin Beyer-Hans and Michèle Wegmann.

Communication and outreach in brief

The numerous events held in 2017 allowed the SNI's outreach team to offer a wide audience an insight into the nanosciences. For example, the SNI's interactive program during tunBasel and the Science Days at Europa-Park Rust (Germany) reached several hundred schoolchildren and inspired enthusiasm for the complex phenomena of the nano world. With the help of numerous students and doctoral students, the SNI team showed visitors the fascinating light effects produced by nanostructured surfaces and how the atomic force microscope is used to conduct detailed analyses of biological nanomachines.

In general, things take a more scientific approach when teachers visit the SNI with their pupils, allowing them to acquaint themselves with a series of fascinating areas of research through laboratory tours and presentations. In 2017, the outreach team welcomed a total of 133 schoolchildren from Switzerland and China on visits to the SNI. A special program, including interactive components, was assembled for the different groups according to the teachers' requests.

Almost 200 school pupils and their teachers also gained a good insight into the SNI's research when the outreach team participated in TecDays at four Swiss high schools. The SNI also took part in the UniKidsCamp, which offers children a varied program combining fun and science-based activities in the summer vacation, as well as the Future Day, which regularly introduces a whole range of research topics to the children of University of Basel staff.

In 2017, the SNI also completed its new website (www.nanoscience.ch), which provides various target groups with comprehensive details of SNI activities and a wealth of information on SNI research. The website also contains the numerous media releases that the SNI prepared in 2017 in collaboration with the University of Basel's communications department, as well as the quarterly 'SNI update' newsletter and descriptions of research projects from the Nano Argovia program and the PhD School.

"We give students the opportunity to experience the challenges of living with Parkinson's."

Dr. Kerstin Beyer-Hans and Dr. Michèle Wegmann

Swiss Nanoscience Institute, University of Basel

nanoscience.ch

New SNI website offers varied and informative content

The new SNI website went live in spring 2017, covering a variety of news and events in both German and English, as well as comprehensive details of the SNI network and its research activities. PhD students and undergraduates will find information that is relevant to their needs, media professionals can access pictures and contact details for experts in specific areas of research, and anyone with an interest in the nanosciences and the SNI can gain an overview of the SNI's wide range of activities.

Incorporating the University of Basel design
Although the SNI is a research platform for the whole of Northwestern Switzerland, it is nevertheless an organizational unit of the University of Basel and adheres to the university's design guidelines in its brochures and information materials. Until a few months ago, the website was the only element that did not match the uniform, functional layout that has now become a distinguishing feature of the University of Basel.

Since spring 2017, the SNI's online presence now also shares the same design. In order to keep up to date with all technical innovations and to ensure access to optimum technical support, the SNI decided to build the site using the 'easyWebLite' system based on WordPress and supported by the University of Basel's IT Services.

Putting news at the forefront
Visitors to the home page are immediately presented with an overview of the SNI and current news, such as media releases, calls for proposals, and upcoming events. "Every one or two weeks, we have news items that we publish on the home page," says Dr. Christel Möller, the SNI team member responsible for large sections of the website. The news items include media releases, announcements, and reports on events, as well as drawing visitors' attention to the successful new student newsletter, for example.

Wide-ranging information on SNI research
The 'Research' section offers a list of all SNI members with links to their contact details and the respective research groups, as well as allowing the user to search for experts in a variety of fields. Under the heading of 'Applied Research', visitors will find the SNI's Nano Argovia program, which they can also access directly via the URL 'www.nano-argovia.swiss'. This section provides a brief and easy-to-understand description of all Argovia projects in the last few years, as well as the information required for prospective project leaders seeking to prepare a proposal.

Of course, 'Research' also covers the SNI's PhD School. As well as listing new projects, it provides a link to the application tool that is used to submit applications and is made available to all project leaders. This section contains a list of important dates and a full directory of PhD students with a brief project description, as well as sharing impressions of events such as 'Nano in the Snow'. Comprehensive information on technology transfer also comes under the heading of research. "In this section, we list a few examples of companies founded by members of the SNI and provide information on the various forms of advice available to SNI members," Christel Möller explains.

The network, the organization, and the people
The next major category, 'About Us', introduces the SNI network and all of its network partners. Among other things, we use this section to report on the many unique individuals who shape the SNI and contribute to its success through their research. Under the heading of 'Nanosciences', non-experts with an interest in the field will find explanations of nano topics, as well as example applications, details of specific SNI projects, and contact details for some of the specialists in the SNI network. The organizational structure, the governance framework, and the regulations governing membership of the SNI can also be found in the 'About Us' section.

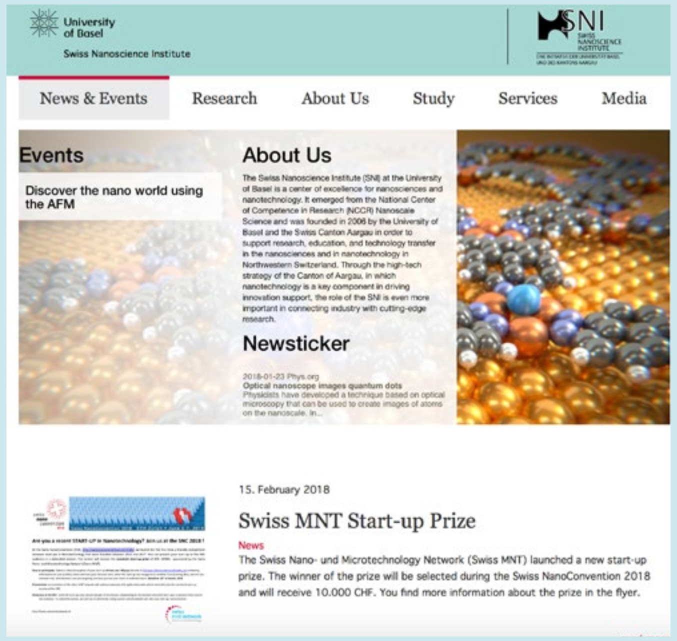
Support throughout the course of studies
The 'Study' section contains an informative website in its own right, providing both bachelor's and master's students with everything they need to know about their degree program. Students can download timetables, gain an overview of block courses, or access important details regarding examinations. Dr. Katrein Spieler, nano studies coordinator, also recently started the Nanoblog, which is used to announce events or share job offers among students. At the same time, the 'Study' section acts as a valuable source of information not only for enrolled students but also for school pupils who are interested in the nanosciences degree program, giving them a good insight into the variety offered by the degree program and the requirements.

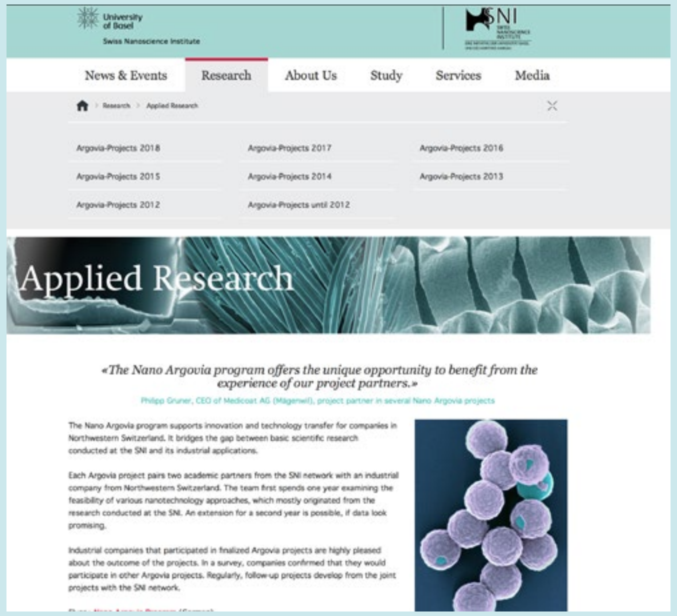
SNI services
The SNI only recently had the opportunity to publish on its website details of the services provided by the Nano Imaging Lab (NI Lab), which was founded in 2016. Now, prospective customers can get to know the NI Lab team online, as well as gaining an overview of the equipment available at the NI Lab, the services it provides, and publications to which the NI Lab's excellent work has contributed. One especially interesting part of the NI Lab page is the picture gallery, which once again reveals the beauty of the hidden world of tiny details.

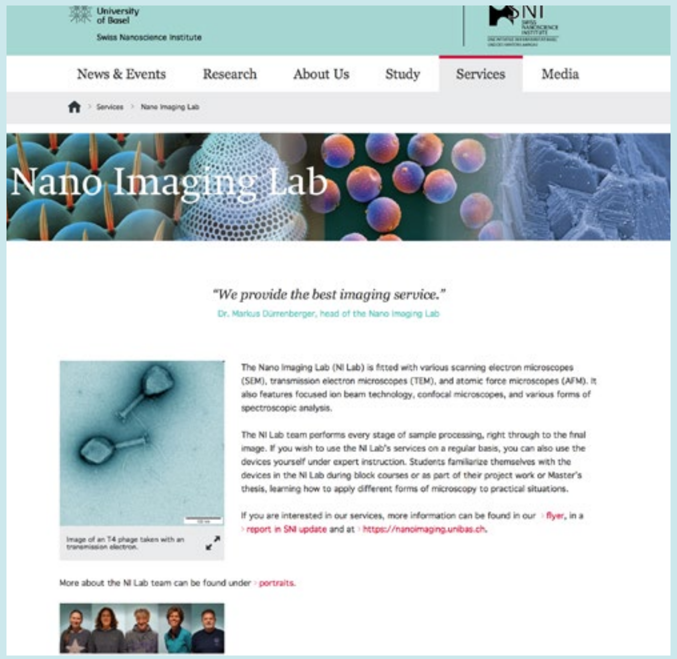
Explanations in words and pictures
Furthermore, the SNI presents a variety of images from across the network in the 'Media' section. This includes the winners of the Nano Image Awards, which are announced on an annual basis. The SNI's newsletter, SNI update, can also be found in this section as well as key publications such as the annual report and brochures. It also lists media releases relating to the SNI or SNI members, as well as a selection of articles about the SNI in various print and online media.

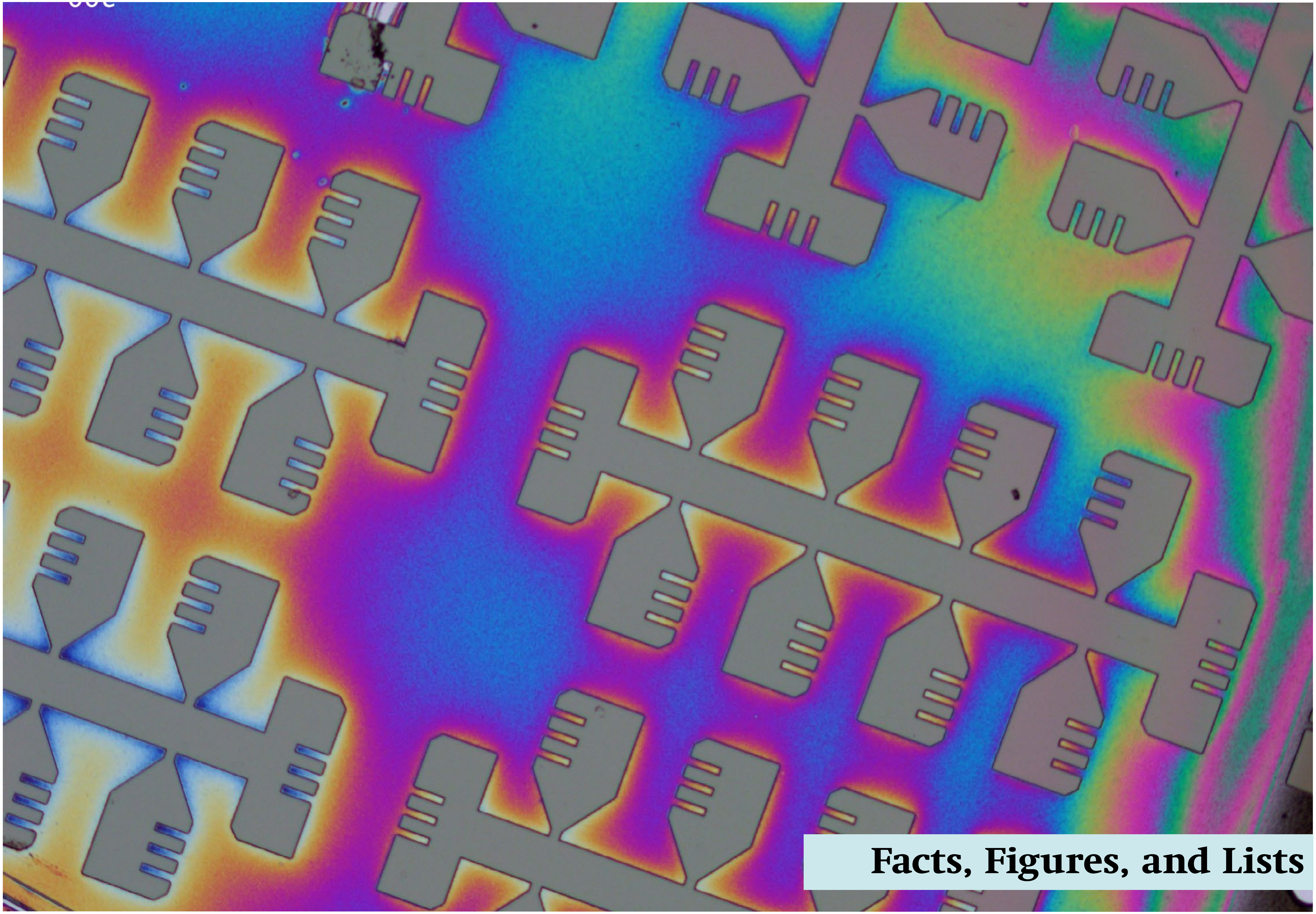
Every now and again, the SNI likes to produce short videos, which can also be found in the 'Media' section. In 2017, for example, a short video was published on the world's first nanocar race, which was won by a team supported by the SNI. In addition, the SNI has put together a video showing testimonials from a number of nanoscience students to provide an overview of why studying nanosciences at the University of Basel is worthwhile.

"We've had a lot of positive feedback about our new site," says SNI Director Christian Schönenberger. "Colin Carter has proven to be an excellent administrator who uses his expertise to quickly bring all our ideas and proposals to life, and the whole migration process went really well thanks to the excellent support we received from IT Services," Christel Möller adds.









Facts, Figures, and Lists

2017 in numbers

6.8
Mio CHF Budget

5
partner organizations

125
students

42
PhD projects

13
applied projects

143
members

24
bachelor degrees

11
master degrees

10
finalized PhD theses

>150
talks

> 66
publications (peer-reviewed)

> 350
media articles

> 400
hours contact with pupils/teachers

Financial report

The Swiss Nanoscience Institute (SNI) was founded at the University of Basel in 2006 on the initiative of the Canton of Aargau in order to secure Northwestern Switzerland's outstanding expertise in nanoscience and nanotechnology for the long term and take it further by establishing a center of excellence. This process has been a clear success – today, the SNI is an established research institution with a distinguished domestic and international reputation, a transregional beacon with a network that integrates all research institutions in Northwestern Switzerland with nanotechnology expertise. Along with its three most important partners – the University of Basel, the University of Applied Sciences Northwestern Switzerland (FHNW) and the Paul Scherrer Institute (PSI) –, the network encompasses the Basel branches of CSEM and ETH Zurich, the Hightech Zentrum Aargau and BaselArea.Swiss. Our mission is to train talented young scientists and promote the acquisition of knowledge through scientific research as well as knowledge and technology transfer for the benefit of industries in Northwestern Switzerland.

The three central pillars – teaching, basic research (hereafter referred to as 'research'), and knowledge and technology transfer (KTT) – are also reflected in the SNI's finances, with research taking the largest share. One source of research funding for the SNI is funding for specific individuals. These include the two Argovia professorships at the University of Basel and the three titular professors from the PSI.

A large proportion of research funding also comes from doctoral students enrolled in the SNI PhD School, all of whom earn their doctorates in the Faculty of Science at the University of Basel. They work on individual and group projects that can be conducted at any institution in the SNI network. Some doctoral students work primarily at the University of Basel, the PSI, or CSEM and ETH Zurich, while others collaborate with two or more institutions.

Knowledge and technology transfer takes place principally in the highly successful Nano Argovia program. This program also represents a significant part of the SNI budget. With the Argovia projects, the SNI has managed to create a platform that meets the needs of researchers, i.e. from industry and the University of Applied Sciences. This is reflected in the extremely positive feedback from industrial partners involved in past applied Argovia projects.

The Nano Imaging Lab has been part of the SNI for a little over a year. This service analyzes nano samples and creates microscopy images (electron microscopy and scanning probe microscopy) for SNI members at reasonable rates. The budget for this service has not yet been transferred to the SNI. This is planned for the end of 2018 and totals CHF ½ million, which the University of Basel will also allocate to the SNI.

The SNI's expenses are divided into the following categories: Management & Overheads, Infrastructure (investments in premises and equipment), KTT & PR (knowledge and technology transfer), Outreach (conferences, brochures, public events, and contact with young people and children), Support (funding at professorship level), Nano Study (bachelor's and master's study programs), and the SNI PhD School.

The following table shows expenses for 2017 by category in accordance with the financial report of the University of Basel dated February 25, 2018.

Expenditure 2017 in CHF

		Univ. Basel	Canton AG	Total
Management	Personnel and operational costs	348'286	279'606	627'891
	Overhead		585'000	585'000
Infrastructure	Infrastructure building	—	—	—
	Infrastructure equipment	84'003	60'584	144'587
KTT & PR	Personnel and operational costs	93'430	142'970	236'400
	Argovia projects		1'025'562	1'025'562
Outreach	Personnel and operational costs	44'771	44'877	89'648
Support	Argovia professorships	565'684	831'017	1'396'701
	PSI professorships		172'995	172'995
Nano Study	Bachelor and master program	301'519	232'324	533'844
PhD School	Research projects	961'901	1'175'657	2'137'559
Total expenditure for 2017 in CHF		**2'399'593**	**4'550'593**	**6'950'186**

As for the last two years, the largest item in the 2017 budget was the SNI PhD School (CHF 2.1 million), which supports young scientists. The second-largest was Support at CHF 1.6 million. These measures support various professors, namely the two Argovia professors (Professor Roderick Lim and Professor Martino Poggio) and, to a lesser extent, three PSI titular professors. Expenses for KTT & PR reached a very similar level at more than CHF 1.3 million. This encompasses knowledge and technology transfer projects such as the highly successful Argovia projects. In 2017, thirteen projects were carried out, three of which were extended on a cost-neutral basis. The remaining 10 projects received CHF 1.37 million in funding of which CHF 1.02 million were accessed.

In addition to the contributions that the SNI receives from the Canton of Aargau and the University of Basel, project partners and industry contributed a total of CHF 3 million to the applied research projects (Argovia projects) via public research funding instruments and their own funds. Here, external funding amounts to more than 70% of total spending. In 2017, 13 Argovia projects were supported; nine (69%) of which partnered with an industrial company from the Canton of Aargau. A total of 42 doctoral students were enrolled in the SNI PhD School and 125 students were enrolled on the nanoscience study program. The two Argovia professors funded by the SNI have both enjoyed great success: Together, they attracted external funding of CHF 1.6 million in 2017 alone and have published articles in world-leading scientific journals.

There is a very good balance between expenditure and income. The status of earmarked funds as per 31/12/2017 is almost identical to that of the previous year. Funds of over CHF 1.6 million that are already allocated but will not take effect until 2018 are to be subtracted from this balance. The actual balance is therefore around CHF 6 million, CHF 0.3 million lower than the previous year.

At this point, we would like to point out that the Canton of Aargau has temporarily reduced its financial commitment for 2016–2018 by CHF ½ million from the original amount of CHF 5 million to CHF 4.5 million. To accommodate this, the SNI was unfortunately required to make some changes. The number of doctoral students that can be accepted into the SNI PhD School each year has been reduced to a maximum of 7. In the long term, this will cap the number of doctoral students at 28 (compared to the current figure of 42) and will result in savings of around CHF ½ million each year. Further cost-saving measures are planned and will have to be implemented should the Canton of Aargau decide not to increase its commitment to the contractually agreed amount of CHF 5 million from 2019.

We would like to thank the Office of Finance and Controlling at the University of Basel for its reporting activities. Even greater thanks are due to the Cantons of Aargau, Basel-Stadt, and Baselland for their goodwill toward the SNI.

The following table shows the SNI balance sheet as at December 31, 2017:

SNI balance sheet 2017

	Univ. Basel	Canton AG	Total
Grants	2'297'019	4'500'000	6'797'019
Investment income	94'992	247'350	342'343
Income	**2'392'011**	**4'747'350**	**7'139'362**
Expenditure	**2'399'593**	**4'550'593**	**6'950'186**
Balance year 2017	**-7'582**	**196'758**	**189'176**
SNI assets per 01/01/2017	**1'686'892**	**5'787'091**	**7'473'983**
Annual balance	-7'582	196'758	189'176
SNI assets per 31/12/2017 in CHF	**1'679'310**	**5'983'849**	**7'663'159**

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Argovia Board

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Prof. Dr. J. Mesot, Director PSI
Prof. Dr. E. Constable, Vice-Rector Research University of Basel
Prof. Dr. C. Schönenberger, Director SNI
Prof. Dr. G.-L. Bona, Director Empa
Dr. W. Riess, IBM Department Head & Coordinator Binnig & Rohrer Nanotechnology Center

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Prof. Dr. J. Gobrecht, Vice-Director (Network)
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Prof. Dr. E. Nigg, Vice-Director (Biozentrum)

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Dr. M. Dürrenberger (NI Lab, SNI)
Prof. Dr. C. E. Housecroft (Chemistry)
Prof. Dr. R. Y. H. Lim (Biozentrum)
Prof. Dr. E. Meyer (Physics)
Prof. Dr. M. Poggio (Physics)
Prof. Dr. C. Schönenberger (SNI and Physics)
Prof. Dr. Hans-Florian Zeilhofer (HFZ, University of Basel and MKG, University Hospital)

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J. Isenburg (Coordination Nanocurriculum)
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S. Hüni (Communication & Outreach)
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D. Bracher, Microscopy and Magnetism, Paul Scherrer Institute
D. Cadeddu, Department of Physics, University of Basel
S. Di Leone, Department of Chemistry, University of Basel
L. Driencourt, CSEM SA Muttenz
T. Einfalt, Department of Chemistry, University of Basel
P. Fountas, Department of Chemistry, University of Basel
M. Gerspach, Department of Chemistry, University of Basel
R. Goers, Department of Chemistry, University of Basel
D. Gonçalves, Intensive Care, University Hospital Basel
L. Gubser, Department of Physics, University of Basel
C. Handschin, Department of Physics, University of Basel
M. Heydari, Department of Physics, University of Basel (Start 2018)
T. Karg, Department of Physics, University of Basel
S. Keller, Department of Chemistry, University of Basel
T. Kozai, Biozentrum, University of Basel (Start 2018)
M. Moradi, School of Life Sciences, University of Applied Sciences Northwestern Switzerland (FHNW)
S. Neumann, Department of Chemistry, University of Basel
T. Nijs, Department of Chemistry, University of Basel
P. Oliva, Biozentrum, University of Basel
N. Opara, Laboratory for Micro- and Nanotechnology, Paul Scherrer Institute
J. Overbeck, Department of Physics, University of Basel
M. Palma, Department of Physics, University of Basel
M. Rehmann, Department of Physics, University of Basel
D. Riedel, Department of Physics, University of Basel
N. Ritzmann, Department of Biosystems Science and Engineering (D-BSSE), ETH Zürich Basel
I. Rouse, Department of Chemistry, University of Basel
Y. Sakiyama, Biozentrum, University of Basel
N. Sauter, Department of Chemistry, University of Basel
J. Schätti, Department of Chemistry, University of Basel
C. Schmidli, Biozentrum, University of Basel
M. Schulzendorf, Department of Physics, University of Basel
D. Sharma, Laboratory for Micro- and Nanotechnology, Paul Scherrer Institute
S. Singh, Biozentrum, University of Basel
D. Sostina, Molecular Nanoscience, Paul Scherrer Institute
W. Szmyt, School of Engineering, University of Applied Sciences Northwestern Switzerland (FHNW)
S. Tarvirdipour, Department of Chemistry, University of Basel
P. Thakkar, Nano-Diffraction, Paul Scherrer Institute
L. Wang, Department of Physics, University of Basel
D. Yildiz, Department of Physics, University of Basel
C. Zelmer, Biozentrum, University of Basel

Projects of the SNI PhD School

Call 2013

Project	Principle Investigator (PI) and Co-PI	PhD Student
P1201 Microfluidics to study nano-crystallization of proteins (PhD finalized in 2017)	T. Braun (Univ. Basel), H. Stahlberg (Univ. Basel)	S. Arnold
P1202 Nanofluidic devices for biomolecules (PhD finalized in 2017)	Y. Ekinci (PSI), T. Pfohl (Univ. Basel)	M. Gerspach
P1203 On surface covalent assembly of coordination polymers with integrated read and write functions (PhD finalized in 2017)	C. Housecroft (Univ. Basel), T. Jung (PSI)	T. Nijs
P1204 Site-specific magnetic studies and control of large self-assembled spin systems (PhD finalized in 2016)	T. Jung (PSI), A. Kleibert (PSI)	J. Nowakowski
P1205 Watching the nanomachinery of the nuclear pore complex at work by high speed-AFM	R. Y. H. Lim (Univ. Basel), C. Gerber (Univ. Basel, NanoMotion)	Y. Sakiyama
P1206 Nanomechanical oscillators for diamond spin-optomechanics (PhD finalized in 2017)	P. Maletinsky (Univ. Basel), R. Warburton (Univ. Basel)	A. Barfuss
P1207 Design of a polymer membrane-based molecular 'hoover'	W. Meier (Univ. Basel), D. Müller (D-BSSE)	R. Goers
P1208 Ultra-sensitive force detection and molecular manipulation (PhD finalized in 2017)	E. Meyer (Univ. Basel), M. Poggio (Univ. Basel)	M. Schulzendorf
P1209 Design of polymer nanoreactors with triggered activity (PhD finalized in 2017)	C. Palivan (Univ. Basel), J. Huwyler (Univ. Basel)	T. Einfalt
P1210 Bottom-up nanowires as ultra-sensitive force transducers	M. Poggio (Univ. Basel), R. Warburton (Univ. Basel)	D. Cadeddu
P1211 Ultraclean suspended graphene (PhD finalized in 2017)	C. Schönenberger (Univ. Basel), D. Zumbühl (Univ. Basel)	C. Handschin
P1212 Nano-photonics with diamond (PhD finalized in 2017)	R. Warburton (Univ. Basel), P. Maletinsky (Univ. Basel)	D. Riedel
P1213 Artificial metalloenzymes for molecular nanofactories (PhD finalized in 2017)	T. Ward (Univ. Basel), S. Panke (D-BSSE)	S. Keller
P1214 An ion-atom hybrid trap on a chip: synthesis and control of nanosystems on the single-molecule level	S. Willitsch (Univ. Basel), P. Treutlein (Univ. Basel)	I. Rouse
P1215 Nanostructure quantum transport at microkelvin temperatures (PhD finalized in 2017)	D. Zumbühl (Univ. Basel), D. Loss (Univ. Basel)	M. Palma

Call 2014

Project	Principle Investigator (PI) and Co-PI	PhD Student
P1301 Energy dissipation over structural and electronic phase transitions	E. Meyer (Univ. Basel), M. Poggio (Univ. Basel)	D. Yildiz
P1302 Probing the initial steps of bacterial biofilm formation: dynamic and molecular principles of surface-based cell motility and mechanosensation	T. Pfohl (Univ. Basel), U. Jenal (Univ. Basel)	N. Sauter
P1303 Assembly and investigation of electrochemically triggered molecular muscles	M. Mayor (Univ. Basel), M. Calame (Univ. Basel)	Y. Aeschi
P1304 Folding mechanisms of beta-barrel outer membrane proteins and their catalysis by natural holdases and foldases	S. Hiller (Univ. Basel), D. Müller (D-BSSE)	N. Ritzmann
P1305 Towards X-FEL based dynamic studies on 2D and 3D nanocrystals of membrane proteins on solid supports	C. Padeste (PSI), H. Stahlberg (Univ. Basel)	N. Opara
P1306 Slow-release nano-pills for mosquitoes for interrupting malaria transmission	P. Hunziker (Univ.-Spital Basel), R. Brun (Swiss TPH, Univ. Basel)	D. Gonçalves
P1307 Optoelectronic nanojunctions	M. Calame (Univ. Basel), M. Mayor (Univ. Basel)	J. Overbeck
P1308 Supramolecular charge and spin architectures produced by chemical clipping	P. Shahgaldian (FHNW), T. Jung (PSI)	M. Moradi
P 1309 Cooling and control of a nanomechanical membrane with cold atoms	P. Treutlein (Univ. Basel), P. Maletinsky (Univ. Basel)	T. Karg
P1310 Plasmonic sensing in biomimetic nanopores	Y. Ekinci (PSI), R. Y. H. Lim (Univ. Basel)	D. Sharma

Call 2015

Project	Principle Investigator (PI) and Co-PI	PhD Student
P 1401 Targeted single cell proteomics using magnetic nanoparticles to study prion-like spreading of amyloid nanoparticles	T. Braun (Univ. Basel), H. Stahlberg (Univ. Basel)	C. Schmidli
P 1402 Lightweight structures based on hierarchical composites	C. Dransfeld (FHNW), C. Schönenberger (Univ. Basel)	W. Szmyt
P 1403 Tailor-made proteins and peptides for quantum interference experiments	V. Köhler (Univ. Basel), M. Mayor (Univ. Basel)	J. Schätti
P 1404 Selective transport of functionalized nanocarriers into biomimetic and natural nuclear pore complexes	R. Lim (Univ. Basel), C. Palivan (Univ. Basel)	C. Zelmer
P 1405 Surface-functionalization of diamond nano-magnetometers for applications in nano- and life sciences	U. Pieles (FHNW), P. Maletinsky (Univ. Basel)	M. Batzer
P 1406 Charge transfer versus charge transport in molecular systems	O. Wenger (Univ. Basel), M. Calame (Univ. Basel)	S. Neumann
P 1407 Coupling a single ion to a nanomechanical oscillator	S. Willitsch (Univ. Basel), M. Poggio (Univ. Basel)	P. Fountas
P 1408 Clean zigzag and armchair graphene nanoribbons	D. Zumbühl (Univ. Basel), D. Loss (Univ. Basel)	M. Rehmann

Call 2016

Project	Principle Investigator (PI) and Co-PI	PhD Student
P 1501 Nanomechanical mass and viscosity measurement-platform for cell imaging	T. Braun (Univ. Basel), E. Meyer (Univ. Basel)	P. Oliva
P 1502 Investigating individual multiferroic and oxidic nanoparticles	A. Kleibert (PSI), M. Poggio (Univ. Basel)	D. M. Bracher
P 1503 Watching giant multienzymes at work using high-speed AFM	T. Maier (Univ. Basel), R. Y. H. Lim (Univ. Basel)	S. Singh
P 1504 Valleytronics in strain-engineered graphene	C. Schönenberger (Univ. Basel), M. Calame (Univ. Basel)	L. Wang
P 1505 A programmable e-beam shaper for diffractive imaging of biological structures at Å resolution	S. Tsujino (PSI), J. P. Abrahams (Univ. Basel)	P. Thakkar

Call 2017

Project	Principle Investigator (PI) and Co-PI	PhD Student
P 1601 Optical plasmonic nanostructures for enhanced photochemistry	E. Constable (Univ. Basel), S. Fricke (CSEM Muttenz)	L. Driencourt
P 1602 Self-assembly and magnetic order of 2D spin lattices on surfaces	T. A. Jung (Univ. Basel), J. Dreiser (PSI)	M. Heydari (Start 2018)
P 1603 A mechano-optical microscope for studying force transduction in living cells	R. Lim (Univ. Basel), E. Meyer (Univ. Basel)	T. Kozai (Start 2018)
P 1604 Selective reconstitution of biomolecules in polymer-lipid membranes	W. Meier (Univ. Basel), U. Pieles (FHNW)	S. Di Leone
P 1605 Topological electronic states in metal-coordinated organic networks	M. Muntwiler (PSI), T. A. Jung (Univ. Basel)	D. Sostina
P 1606 Smart peptide nanoparticles for efficient and safe gene therapy	C. Palivan (Univ. Basel), J. K. Benenson (D-BSSE)	S. Tarvirdipour
P 1607 Understanding and engineering of phonon propagation in nanodevices by employing energy resolved phonon emission and adsorption spectroscopy	I. Zardo (Univ. Basel), C. Schönenberger (Univ. Basel)	L. Gubser

Argovia projects

Prolonged projects

(with and without financial support)

Project	Project leader	Project partner
A10.8 Atolys: Atomic-scale analysis of SiC-Oxide interface for improved high-power MOSFETs	S. Goedecker (Univ. Basel)	T. Jung (PSI), J. Lehmann (ABB Switzerland Ltd, Baden-Dättwil)
A10.10 Nano-Cicada-Wing: Bactericidal nanostructures mimicking cicada wings for consumer products	E. Meyer (Univ. Basel)	M. Kisiel (Univ. Basel), T. Glatzel (Univ. Basel), J. Köser (FHNW), H. Hug (DMS Nutritional Products Ltd, Kaiseraugst)
A11.01 CerInk: Biomimetic ceramic scaffolds with density gradient and improved mechanical stability fabricated by Binder-into-Bed 3D-printing and ceramic NanoInk	A. Testino (PSI)	R. Schumacher (FHNW), C. Ludwig (PSI), P. Gruner (Medicoat AG, Mägenwil)
A11.04 HPD4FED: Hybrid pixel detectors for electron diffraction of nano-samples	J. P. Abrahams (Univ. Basel)	T. Grüne (PSI), H. Stahlberg (Univ. Basel), B. Schmitt (PSI), C. Schulze-Briese (Dectris Ltd., Baden)
A11.05 IgG AptaNP: IgG Aptamer-Nanopartikel für die Entwicklung von Zelllinien für die Antikörperproduktion	G. Lipps (FHNW)	M. Held (D-BSSE ETHZ Basel), R. Pellaux (FGen GmbH, Basel)
A11.10 NanoSilkTex: Development of nanostructured silk fibroin-synthetic textile composites	O. Germershaus (FHNW)	U. Pieles (FHNW), M. Schönenberger (Univ. Basel), M. Height (HeiQ Materials AG, Schlieren, formerly Bad Zurzach), W. Bender (HeiQ Materials AG, Schlieren, formerly Bad Zurzach)
A.11.12 NF-Optics: Uniaxilly 0riented anisotropic electrospun nano-fibrous layers for optical applications	M. Stalder (CSEM Muttenz)	U. Pieles (FHNW), A. Hafner (BASF Schweiz AG, Basel)

Projects started in 2017

Project	Project leaderr	Project partner
A12.01 A3EDPI: Applicability of 3D electron diffraction in the pharmaceutical industry	T. Grüne (PSI)	E. van Genderen (PSI), J. P. Abrahams (Univ. Basel), S. De Carlo (Dectris AG, Baden-Dättwill)
A12.04 AntibakVlies: Antibakterielle Ausstattung von Vliesmaterialien mittels e-grafting	S. Neuhaus (FHNW)	J. Köser (FHNW), H. Härdi (Jakob Härdi AG, Oberentfelden)
A12.09 MicroSlide: Biomimetische Mikrostrukturen zur Verbesserung des Gleit- und Verschleissverhaltens	C. Rytka (FHNW)	R. Holtz (FHNW), H. Schift (PSI), M. Siegfried (BRUGG Liftung, Brugg)
A12.10 MiPIS: Microfluidic protein isolation, stabilization and cryo-EM preparation for high-resolution structural analysis	T. Braun (Univ. Basel)	M. Hürzeler (FHNW), M. Chami (Univ. Basel), M. Hennig (leadXpro, Villigen)
A12.13 PlasmoRetarder: Plasmonic nanoscale retarder controlled with liquid crystals	B. Gallinet (CSEM Muttenz)	Y. Ekinci (PSI), J. Dahdah (Rolic Technologies Ltd., Allschwil)
A12.17 3D Cellophil® membrane: 3D printable nano porose Cellophil® membranes with nano hydroxyapatite gradient for tissue regeneration applications	U. Pieles (FHNW)	S. Stübinger (HFZ, Univ. Basel), C. Geraths (CIS Pharma AG, Bubendorf)

SNI impact

Peer-reviewed articles

Aeschi, Y. et al. Assembly of [2]Rotaxanes in water
Eur J Org Chem 2017, 4091-4103
doi:10.1002/ejoc.201700640 (2017)

Alsteens, D. et al. Atomic force microscopy-based characterization and design of biointerfaces
Nat Rev Mater 2, 17008
doi:10.1038/natrevmats.2017.8 (2017)

Arnold, S. A. et al. Blotting-free and lossless cryo-electron microscopy grid preparation from nanoliter-sized protein samples and single-cell extracts
J Struct Biol. 197(3): 220-226
doi:10.1016/j.jsb.2016.11.002 (2017)

Benning, F. M. C. et al. High-speed atomic force microscopy visualization of the dynamics of the multienzyme fatty acid synthase
Acs Nano 11, 10852-10859
doi:10.1021/acsnano.7b04216 (2017)

Cadeddu, D. et al. Electric-field sensing with a scanning fiber-coupled quantum dot
Phys Rev Appl 8, 031002
doi:10.1103/PhysRevApplied.8.031002 (2017)

Caloz, M. et al. Optically probing the detection mechanism in a molybdenum silicide superconducting nanowire single-photon detector
Appl Phys Lett 110, 083106
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Dettwiler, F. et al. Stretchable persistent spin helices in GaAs quantum wells
Phys. Rev. X 7, 031010
doi: 10.1103/PhysRevX.7.031010 (2017)

Dufrêne, Y. F. et al. Imaging modes of atomic force microscopy for application in molecular and cell biology
Nat Nanotechnol 12, 295-307
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Nano Lett 17, 5790-5798
doi:10.1021/acs.nanolett.7b02886 (2017)

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doi:10.1039/c7cp02592k (2017)

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Nanoscale 10, 1337-1344
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Osmani, B., Töpper, T., Siketanc, M., Kovacs, G. & Müller, B. Electrospraying and ultraviolet light curing of nanometerthin polydimethylsiloxane membranes for low-voltage dielectric elastomer transducers

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Book chapter

Gnecco, E., Pawlak, R., Kisiel, M., Glatzel, T. & Meyer, E. Nanotribology and Nanomechanics: Atomic Scale Friction Phenomena, First Edition. Edited by Bhushan, B. (Springer, Cham, 2017).
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Gnecco, E., Pawlak, R., Kisiel, M., Glatzel, T. & Meyer, E. Springer Handbook of Nanotechnology: Atomic Scale Friction Phenomena, Forth Edition. Edited by Bhushan, B. (Springer Berlin Heidelberg, 2017).
ISBN: 978-3-662-54355-9

Maier, T. natura obscura: 200 Naturforschende – 200 Naturphänomene – 200 Jahre Naturforschende Gesellschaft in Basel: Fliessbandarbeit in der Biologie, First Edition. Edited by Mäser, P. (Schwabe Verlag Basel, 2017).
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Müller, B. & Van de Voorde, M. Nanoscience and Nanotechnology for Human Health: Nanotechnology in the Treatment of Incontinence, First Edition. Edited by Müller, B. & Van de Voorde, M. (Wiley-VCH: Weinheim, 2017).
ISBN: 978-3-527-33860-3

Willitsch, S. Advances in Chemical Physics: Chemistry with Controlled Ions, First Edition. Edited by Rice, S. A. & Dinner, A. R. (John Wiley & Sons, Inc., 2017).
ISBN: 978-1-119-32457-7

Zhang, D. & Willitsch, S. Cold Chemistry: Molecular Scattering and Reactivity Near Absolute Zero: Cold Ion Chemistry, First Edition. Edited by Dulieu, O. & Osterwalder, A. (Royal Society of Chemistry Publishing, 2018).
ISBN: 978-1-78262-597-1

Invited talks

Braun, T. Microfluidic Sample Preparation for Electron Microscopy: Opportunities, Challenges and 'Visual Proteomics', Gordon Research Conference (Three Dimensional Electron Microscopy), Diablerets (CH), June 11–16, 2017

Braun, T. Microfluidic Sample Preparation for Electron Microscopy: Opportunities, Challenges and 'Visual Proteomics', Workshop on Advanced Topics in EM Structure Determination: Challenges and Opportunities, New York (USA), Oct 29–Nov 3, 2017

Gerber, C. Atomic Force Microscopy (AFM), the ultimate toolkit for nanoscience and technology, Institute of Nanoscience and Nanotechnology of the University of Barcelona (N2UB), Barcelona, Spain, January 26, 2017

Gerber, C. Atomic Force Microscopy (AFM), the ultimate toolkit for nanoscience and technology, Trends in Nanoscience 2017, Kloster Irsee, Germany, March 27–30, 2017

Gerber, C. Atomic Force Microscopy (AFM), the ultimate toolkit for nanoscience and technology, Lecture at ETHZ, Zurich, Switzerland, May 5, 2017

Gerber, C. Atomic Force Microscopy (AFM) – the ultimate toolkit for nanoscience and technology, I-sense Biannual meeting at Regents University London, London, Great Britain, December 5, 2017

Glatzel, T. Porphyrins on titania, The 2nd International Symposium on Recent Trends in Analysis Techniques for Functional Materials and Devices, Osaka, Japan, January 18, 2017

Glatzel, T. Porphyrins on titania, Research Seminar, IPCMS-CNRS, Université de Strasbourg, Strasbourg, France, May 10, 2017

Glatzel, T. Advanced Kelvin probe force microscopy, Zurich Instruments Users Meeting, Mainz, Germany, June 22, 2017

Hiller, S. Chaperone-client interactions: from basic principles to roles in health and disease, 20th ISMAR Meeting of the International Society for Magnetic Resonance, Quebec, Canada, July 24, 2017

Hiller, S. Functional aspects of the dynamic proteins VDAC and α-synuclein, EMBO-FEBS Lecture Course: Mitochondria in Life, Death and Disease, Bari, Italy, October 12, 2017

Hiller, S. Chaperone-client interactions: from basic principles to roles in health and disease, 56th Annual Meeting of the NMR Society of Japan, Tokyo, Japan, November 15, 2017

Jung, T.A. Programming electronic and spin states in 2D supramolecular architectures by modifications on the single atomic or molecular level, ISSS Tsukuba, Japan, October 22–26, 2017

Jung, T.A. Unravelling surface enabled phenomena in low dimensional systems, Elecmol, Strasbourg, France, August 22–26, 2017

Jung, T.A. Hierarchical Assembly of Xe atoms in an Atomically Precise Array of Quantum Boxes, ACS National Meeting, San Francisco, USA, April 2–6, 2017

Jung, T.A. Magnetism in 2D chessboard-like molecular layers, International Workshop on Nanomaterials and Nanodevices, Beijing, July 3–9, 2017

Jung, T.A. On-Surface Coordination Chemistry and Magnetochemistry, International Conference on Functional Nanomaterials & Nanotechnology (ICFNN-2017), Katmandu, Nepal, October 10–13, 2017

Kleibert, A. Magnetism at the nanoscale studied using X-PEEM at the Swiss Light Source, NSLS-II and CFN Users Meeting, Brookhaven National Laboratory, Upton, USA, May 15–17, 2017

Kleibert, A. Investigating enhanced and metastable magnetism in size- and shape-selected, individual nanoparticles, Moscow International Symposium on Magnetism, Moscow, Russia, July 1–5, 2017

Lim, R. Molecular transport control, BaselAreaSwiss Technology Circle Nanomedicine, Basel, Switzerland, March 21, 2017

Lim, R. Mechanosignalling into the cell nucleus, 5th Swiss-Japan Biomechanics Meeting, Zermatt, Switzerland, September 14–16, 2017

Lim, R. Karyopherins control nuclear pore complex function, Nuclear Transport, Sant Feliu de Guixols, Spain, September 23–28, 2017

Lim, R. The nuclear pore complex: paradoxes and possibilities, Frontiers in Single Molecule Biophysics, Neve Ilan, Israel, October 15–18, 2017

Lim, R. Watching nuclear pore complexes at work, 25th International Colloqium on Scanning Probe Microscopy (ICSPM25), Atagawa, Japan, December 7–9, 2017

Maier, T. The architecture of human mTOR complex I, IPBS Student Symposium, Toulouse, France, October 26, 2017

Maletinsky, P. Single spin magnetometry of condensed matter systems, EMPA seminar, Dübendorf, Switzerland, January 18, 2017

Maletinsky, P. Nanoscale quantum sensing with single spins, WE - Heraeus - Seminar "Quantum-Limited Metrology and Sensing", Bad Honnef, Germany, February 9, 2017

Maletinsky, P. Single spin magnetometry of antiferromagnets and superconductors, MRS spring meeting, Phoenix, USA, April 17, 2017

Maletinsky, P. Single spin quantum sensing of superconductors and antiferromagnets, Physics Colloquium, Konstanz, Germany, May 16, 2017

Maletinsky, P. Single spin quantum sensing of superconductors and antiferromagnets, UCL seminar, London, Great Britain, June 7, 2017

Maletinsky, P. Single spin quantum sensing and imaging of magnetic fields, CEWQO, Kopenhagen, Denmark, June 26, 2017

Maletinsky, P. Single spin quantum sensing for antiferromagnetic spintronics, PSI colloquium, Villigen, Switzerland, August 18, 2017

Meyer, E. Pulling nanoribbons and molecular chains across surfaces, 7th European Nanomanipulation Workshop, Jena, Germany, February 20–22, 2017

Meyer, E. Force microscopy as a local tool to investigate mechanism of friction, MANA International Symposium 2017, Tsukuba, Japan, February 28–March 3, 2017

Meyer, E. Manipulative force microscopy: pulling molecular chains and nanoribbons, ACS 253rd National Meeting, San Francisco, USA, April 3, 2017

Meyer, E. Graphene nanoribbons and polymeric chains sliding on Au(111), Colloquium, University of Goettingen, Goettingen, Germany, May 17, 2017

Meyer, E. Mechanical force spectroscopy with single molecules and atoms, Nanoday at Bilkent University, Ankara, Turkey, May 25, 2017

Meyer, E. Novel force spectroscopy to probe chemical interactions, Swiss NanoConvention, Fribourg, Switzerland, June 1, 2017

Meyer, E. Some remarks about AFM: from the early days to modern science applications, 20th Anniversary Symposium of Nanosurf, Basel, Switzerland, June 9, 2017

Meyer, E. Graphene nanoribbons and polymeric chains sliding on Au(111), Trends in Nanotribology, ICTP, Trieste, Italy, June 26–30, 2017

Meyer, E. Graphene nanoribbons and polymeric chains sliding on Au(111), Nano TR 13, Antalya, Turkey, October 20–24, 2017

Meyer, E. Superlubricity on the nanometer scale, Colloquium, University of Giessen, Giessen, Germany, November 17, 2017

Müller, D. J. Cellular mechanics, Annual Dutch Biophysics Meeting, Veldhoven, Netherlands, October 2–3, 2017

Müller, D. J. Membrane protein insertion and folding, Workshop on New Horizon in Membrane Transport and Communication, Frankfurt, Germany, October 5–9, 2017

Palivan, C. G. Protein-polymer supramolecular assemblies: bio-nano functional systems, Tübingen University colloquium, Tübingen, Germany, January 23, 2017

Palivan, C. G. Protein-polymer membranes as functional membranes for development of artificial organelles, International Conference Biomolecules and Nanostructures, Podlesice, Poland, March 10–14, 2017

Palivan, C. G. "Smart" functional nanosystems: polymer membranes decorated with proteins, 9th International Conference on Advanced Materials- ROCAM2017, Bucharest, Romania, July 10–14, 2017

Palivan, C. G. Functional membranes based on protein-polymer membranes, TehMem 2017, Vienna, Austria, August 7–9, 2017

Palivan, C. G. How FCS and FCCS give details about artificial organelles as novel solution for protein therapy?, FCS Workshop 2017 „Fluorescence Correlation Spectroscopy in Soft Matter Science", Munich, Germany, October 11–12, 2017

Pawlak, R. Nanocar race, Internet of Things, Geneva, Switzerland, June 7–9, 2017

Pawlak, R. Probing majorana wavefuntion in superconducting Fe chains, Qmol, Ascona, Switzerland, September 10–14, 2017

Plodinec, M. Mechanobiology of epithelia on native basement membranes and relevance for cancer cell invasion and clinics, Physical Science of Cancer Gordon Research Conference, Galveston, USA, February 5–9, 2017

Plodinec, M. Mechanobiology of epithelia on native basement membranes and relevance for cancer cell invasion, EuroCellnet workshop in Prague, Prague, Czech Republic, March 23–24, 2017

Plodinec, M. Mechanobiology of epithelia on native basement membranes and relevance for cancer cell invasion, 8th Annual Symposium on Physics of Cancer, Leipzig, Germany, October 3–5, 2017

Poggio, M. Mechanical sensing of nanomagnetic systems, Frontiers of Nanomechanical Systems, La Thuile, Italy, February 10, 2017

Poggio, M. Nanowire force microscopy and dynamic cantilever magnetometry, Spin Mechanics 4, Lake Louise, Canada, February 24, 2017

Poggio, M. Force sensing with nanowires, Trends in Nanoscience 2017, Kloster Irsee, Germany, March 27–30, 2017

Poggio, M. Nanomechanics and nanomagnetism, Physics Department Colloquium, University of Ulm, Germany, June 19, 2017

Poggio, M. Nanomechanics and nanomagnetism, Department Seminar, CNRS Grenoble, France, June 29, 2017

Poggio, M. Magnetization configurations and reversal in ferromagnetic nanotubes, 13th International Workshop on Magnetism & Superconductivity at the Nanoscale, Targona, Spain, July 6, 2017

Poggio, M. Mechanical sensing of nanomagnetic systems, Foundations and Applications of Nanomechanics, Trieste, Italy, September 26, 2017

Poggio, M. Mechanical sensing of nanomagnetic systems, Opto- and Nanomechanics Research Group (MecaQ) Annual Meeting, Paris, France, December 13, 2017

Riedel, D. Deterministic enhancement of coherent photon generation from a nitrogen-vacancy center in ultrapure diamond, SPIE Optics+Photonics, San Diego, USA, August 6, 2017

Riedel, D. Deterministic enhancement of coherent photon generation from a nitrogen-vacancy center in ultrapure diamond, SPIE Quantum Photonic Devices, San Diego, USA, August 7–8, 2017

Schönenberger, C. Quantum transport along pn-junctions in ballistic graphene, XIII Rencontres du Vietnam on nanophysics: from Fundamentals to Applications, Quy Nhon, Vietnam, July 30–August 5, 2017

Schönenberger, C. Quantum transport along pn-junctions in ballistic graphene, Workshop on Fundamentals on Quantum Transport at the ICTP, Trieste, Italy, July 31 – August 11, 2017

Schönenberger, C. Cooper pair splitter, Workshop on Electronic Properties of Carbon Based Nanostructures, Rattenberg, Germany, September 18–20, 2017

Serdiuk, T. Membrane protein insertion and folding, Membrane Protein Gordon Research Conference (GRC), Easton, USA, June 12–17, 2017

Shields, B. Diamond parabolic reflectors for efficient scanning nitrogen-vacancy magnetic imaging, Frontiers in Quantum Nanophotonics, Monte Verita, Switzerland, August 20, 2017

Shields, B. Nanophotonics for optical addressing of single solid state spins, Single Photons Single Spins Conference 2017, Troyes, France, August 29, 2017

Thiel, L. Quantitative nanoscale vortex imaging using a cryogenic quantum magnetometer, Spintech, Tokyo, Japan, June 5, 2017

Treutlein, P. Hybrid atom-membrane optomechanics, CLEO Special Symposium on Optomechanics, San Jose, USA, May 18, 2017

Treutlein, P. Hybrid atom-membrane optomechanics, Conference on Foundations and Applications of Nanomechanics ICTP, Trieste, Italy, September 25, 2017

Warburton, R. Spintronics, Summer School on Quantum and Non-Linear Optics, Gilleleje, Denmark, June 19–24, 2017

Warburton, R. The solid-state spin-photon interface: semiconductor quantum dots, the NV centre in diamond, Quantum Information Workshop, Hong Kong, July 7–9, 2017

Warburton, R. Spin-photon interface with solid-state emitters: semiconductor quantum dots and NV centres in diamond, Conference on Quantum Nanophotonics, Monte Verita, Switzerland, August 20–25, 2017

Warburton, R. Quantum photonics with solid-state emitters, Joint Annual Meeting of SPS and ÖPG, Geneva, Switzerland, August 21–25, 2017

Warburton, R. Spin-photon interface with solid-state emitters, Solid State Nano-Photonics for Quantum Science and Technology, Grasmere, UK, September 25–28, 2017

Ward, T. Artificial metalloenzymes for in vivo catalysis: challenges and opportunities, GFPP, Arcachon, France, March 27, 2017

Ward, T. Artificial metalloenzymes for in vivo catalysis: challenges and opportunities, Marseille University, Marseille, France, April 28, 2017

Ward, T. Artificial metalloenzymes: challenges and opportunities, Novartis, Basel, Switzerland, May 2, 2017

Ward, T. Endowing organometallic catalysis with a genetic memory, Technion University, Haifa, Israel, May 7, 2017

Ward, T. Endowing organometallic catalysis with a genetic memory, Osaka University, Osaka, Japan, May 12, 2017

Ward, T. Artificial metalloenzymes for in vivo catalysis: challenges and opportunities, Osaka University, Osaka, Japan, May 13, 2017

Ward, T. Endowing organometallic catalysis with a genetic memory, Kyoto University, Kyoto, Japan, May 15, 2017

Ward, T. Artificial metalloenzymes for in vivo catalysis: challenges and opportunities, University Geneva, Geneva, Switzerland, May 29, 2017

Ward, T. Artificial metalloenzymes for in vivo catalysis: challenges and opportunities, EPFL, Lausanne, Switzerland, May 30, 2017

Ward, T. Artificial metalloenzymes for in vivo metathesis, ISOM, Zurich, Switzerland, July 9, 2017

Ward, T. Artificial metalloenzymes: challenges and opportunities, ICBIC, Florianopolis, Brasil, August 3, 2017

Ward, T. Artificial metalloenzymes: challenges and opportunities, ACS Meeting, Washington DC, USA, August 22, 2017

Ward, T. Artificial metalloenzymes: challenges and opportunities, First International Symposium on Sustainable Catalysis, Freiburg, Germany, September 26, 2017

Ward, T. Artificial metalloenzymes: challenges and opportunities, University of Berkeley, Berkeley, USA, September 27, 2017

Ward, T. Endowing organometallic catalysis with a genetic memory, University of Berkeley, USA, October 3, 2017

Ward, T. Artificial metalloenzymes: challenges and opportunities, Wageningen Universtiy, Wageningen, Netherlands, December 19, 2017

Willitsch, S. Cold ion-neutral collisions: advances in theory and experiment, Workshop on Spectroscopy, Dynamics and Applications of Cold Molecular Ions, Les Houches, France, May 28, 2017

Willitsch, S. Cold and controlled ion-neutral reactions, 27. International Symposium on Molecular Beams, Nijmegen, Holland, June 25, 2017

Willitsch, S. Cold ion-neutral collisions: advances in theory and experiment, 24e Congres General de la Societe Francaise de Physique, Orsay, France, July 3, 2017

Willitsch, S. Cold and controlled chemistry: from small molecules to complex systems, XXVI. Dynamics of Molecular Collisions, Tahoe City, USA, July 9, 2017

Willitsch, S. Collision dynamics in cold ion-atom hybrid systems, Workshop on Controllable Quantum Impurities in Physics and Chemistry, Klosterneuburg, Austria, August 16, 2017

Willitsch, S. High-resolution and precision spectroscopy of cold molecular ions in traps, 25th Colloquium on High-resolution Molecular Spectroscopy, Helsinki, Finland, August 20, 2017

Willitsch, S. Ion-atom and ion-molecule hybrid experiments: from cold to controlled chemistry, Joint Iberian Meeting on AMO Physics, Barcelona, Spain, September 14, 2017

Willitsch, S. The role of long-range interactions in ion-neutral hybrid systems, 651. WE Heraeus Seminar “Long-range interactions”, Bad Honnef, Germany, October 27, 2017

Zardo, I. Investigating the thermoelectric properties of semiconductor nanowires, Materials Research Society Meeting, Phoenix, USA, April 17–21, 2017

Zardo, I. Nanophononics today and perspectives, ICMAB-CSIC Institute, Barcelona, Spain, June 26, 2017

Zardo, I. Nanophononics: phonon engineering and manipulation, FisMat 2017, the Italian National Conference on the Physics of Matter, Trieste, Italy, October 1–6, 2017

Zardo, I. Thermal transport in semiconductor nanowires, Trobades Científiques de la Mediterrània (TCM - Scientific Meetings of the Mediterranean), Menorca, Spain, October 18–20, 2017

Contributed talks

Appel, P. Antiferromagnetic domain imaging using scanning NV-magnetometry, MRS fall meeting, Boston, USA, November 26 – December 1, 2017

Bracher, D. M. Investigating magnetism in nano-sized goethite particles, DPG Spring Meeting 2017, Dresden, Germany, March 19–24, 2017

Bracher, D. M. Direct observation of room temperature antiferromagnetism in individual goethite nanoparticles, IEEE International Magnetics Conference INTERMAG Europe 2017, Dublin, Ireland, April 24–28, 2017

Bracher, D. M. Antiferromagnetic order probed in individual goethite nanoparticles, Joint Annual Meeting of SPS and ÖPG, Genève, Switzerland, August 21–25, 2017

Braun, T. Cryo-Electron Microscopy Grid Preparation from Nanoliter-Sized Protein Samples and Single-Cell Extracts. 9thInternational Conference on Structural Biology, Zurich (CH), September 18–20, 2017

Dutta, D. Atomistic insight into carbon defects at thermally grown SiC/SiO_2 interfaces: theory and experiment, International Conference on SiC and Related Material, Washington DC, USA, September 17–22, 2017

Dutta, D. Atomic scale investigation of near interface defects at the SiC/SiO_2-interface: microscopy, atom probe tomography and theory, ICFNN- 2017, Kathmandu, Nepal, October 10–13, 2017

Dutta, D. Atomistic investigation of near interface defects at the SiC/SiO_2-interface, 8th International Symposium on Surface Science (ISSS-8), Tsukuba, Japan, October 22–26, 2017

Einfalt, T. Biomimetic engineering of stimuli responsive artificial cell organelle membranes, International Conference on Molecular Systems Engineering, Basel, Switzerland, August 26–29, 2017

Glatzel, T. Adsorption of porphyrin based dye molecules on titania, EMRS Fall meeting 2017, Warsow, Poland, September 18, 2017

Glatzel, T. Dye precursor molecules on NiO(001) studied by non-contact atomic force microscopy, 20th International Conference on Non-Contact Atomic Force Microscopy (NC-AFM 2017), Suzhou, China, September 26, 2017

Gross, B. Néel-type skyrmions in multiferroic lacunar spinels – Mapping out a stability phase diagram using dynamic cantilever magnetometry, Solitons and Skyrmion Magnetism 2017, San Sebastian, Spain, June 20, 2017

Hiller, S. Chaperone-client interactions: from basic principles to roles in health and disease, 31st Annual Symposium of the Protein Society, Montreal, Canada, July 25, 2017

Hinaut, A. Caracterisation ncAFM de defauts atomiques crees par plasma a basse temperature sur la surface de KBr(001), Forum des microscopies a sonde locale, Montpellier, France, March 20, 2017

Hinaut, A. Atomic scale defects on KBr(001) created by low temperature plasma and investigated by ncAF, The 19th International Scanning Probe Microscopy Conference, Kyoto, Japan, May 17, 2017

Jung, M. Microwave photodetection in an ultraclean suspended bilayer graphene p-n junction, EMRS spring conference 2017, Strasbourg, France, May 22–26, 2017

Keller, S. Towards a photo-driven artificial hydrogenase based on the biotin-streptavidin technology, SCS Swiss Snow Symposium, Saas-Fee, Switzerland, January 27–29, 2017

Kisiel, M. Giant dissipation peaks onto $SrTiO_3$ surface measured by pendulum AFM, ICTP-COST-MODPHYSFRIC Conference, Trieste, Italy, June 26–30, 2017

Lang, H. P. Smart medical devices: PATLiSci II – Probe array technology for life sciences / Rapid sensing of cancer, Design Automation & Test in Europe (DATE’17), Lausanne, Switzerland, March 28, 2017

Lim, R. Spatiotemporal dynamics of the nuclear pore complex transport barrier, 12th Symposium on Trends in Structural Biology, Zurich, Switzerland, February 6–7, 2017

Makk, P. Magneto-oscillations in high-mobilty pn junction, Graphene week 2017, Athens, Greece, September 25–29, 2017

Meyer, E. Pulling molecular chains and nanoribbons, Workshop on SPM & onsurface chemistry, Prague, Czech Republic, May 22–23, 2017

Meyer, E. Scanning probe microscopy to explore majorana bound states, Novel Trends in Topological Insulators (NTTI2017), Ascona, Switzerland, July 17–21, 2017

Müller, B. The nanostructure of human teeth in health and disease, E-MRS Symposium K "Bioinspired and biointegrated materials as new frontiers nano materials VII", Strasbourg, France, May 22, 2017

Müller, B. How a Nanosurf product can support the development of artificial muscles, Scientific symposium celebrating Nanosurf's 20th anniversary, Basel, Switzerland, June 9, 2017

Müller, B. Nanometer-thin membranes based on entangled PDMS for soft electronics, MNE - 43rd International Conference on Micro and Nanoengineering, Braga, Portugal, September 18–22, 2017

Opara N. et al., Direct protein crystallization on solid supports economizes sample consumption in serial femtosecond crystallography. 9th International Conference on Structural Biology September 18-20, 2017 Zurich, Switzerland

Osmani, B. Electrospraying and ultraviolet light curing of nanometer-thin polydimethylsiloxane membranes for low-voltage dielectric elastomer transducers, SPIE – Smart Materials and Structures, Portland, USA, March 25–29, 2017

Osmani, B. Soft and nanostructured electrodes for applications in artificial muscles, neuroprosthetics and flexible electronics, CLINAM – 10th European Conference for Clinical Nanomedicine, Basel, Switzerland, May 7–10, 2017

Osmani, B. Soft and nanostructured metal electrodes for flexible electronics, SSBE – Swiss Society for Biomedical Engineering, Winterthur, Switzerland, August 30, 2017

Overbeck, J. Optoelectronic Properties of Graphene under Strain, Empa PhD Symposium, Dübendorf (CH), November 13, 2017

Palivan, C. G. Biomimetic artificial organelles with in vitro and in vivo reduction triggered activity, ACS Meeting, Washington DC, USA, August 20–24, 2017

Panatal, R. Constructing molecular factories from isolated nuclei, NCCR Molecular Systems Engineering Fellows Retreat, Grindelwald, Switzerland, May 3–5, 2017

Panatal, R. Molecular logistics and transport systems, NCCR Molecular Systems Engineering Technology Pitch, Basel, Switzerland, November 17, 2017

Pawlak, R. Design and characterization of an electrically powered single molecule, ncAFM2017, Suzhou, China, September 25–29, 2017

Rickhaus, P. Measurement of valley-isospin oscillations in graphene, Graphene week 2017, Athens, Greece, September 25–29, 2017

Riedel, D. Enhancement of resonant transitions via coupling to a fully tunable Fabry-Pérot microcavity, NCCR QSIT General Meeting, Arosa, Switzerland, February 1–3, 2017

Riedel, D. Enhancement of resonant transitions via coupling to a fully tunable Fabry-Pérot microcavity, Quantum Nanophotonics, Benasque, Spain, February 26 – March 3, 2017

Riedel, D. Enhancement of the zero-phonon emission rate of an NV centre in minimally processed diamond, DPG Tagung, Dresden, Germany, March 20–24, 2017

Ritzmann, N. Controlled insertion of fusion membrane proteins, International Conference on Molecular Systems Engineering, Basel, Switzerland, August 26–29, 2017

Rossi, N. Torque magnetometry of individual GaAs nanowires with ferromagnetic MnAs tips, SpinTech IX, Fukuoka, Japan, June 6, 2017

Sauter, N. Flagellum dynamics during cell division in Caulobacter crescentus, Biozentrum PhD Retreat, Martigny, Switzerland, June 28, 2017

Töpper, T. Leakage current, self-clearing and actuation efficiency of nanometer-thin, low-voltage dielectric elastomer transducers tailored by thermal evaporation, SPIE – Smart Materials and Structures, Portland, USA, March 25–29, 2017

Yildiz, Y. Image states and energy dissipation on Bi_2Te_3 surface, The 19th International Scanning Probe Microscopy Conference, Kyoto, Japan, May 16–19, 2017

Yildiz, Y. Image states and energy dissipation on Bi_2Te_3 surface, Trends in Nanotribology 2017, Trieste, Italy, June 26–30, 2017

Yildiz, Y. Electronic and frictional properties of Bi_2Te_3 (0001) surface, 13th International Nanoscience & Nanotechnology Conference, Antalya, Turkey, October 22–25, 2017

Zelmer, C. Selective uptake of functional hybrid-polymer vesicles into nuclei of living cells, NCCR Molecular Systems Engineering Fellows Retreat, Grindelwald, Switzerland, May 3–5, 2017

Selected articles in the media

www.ww-magazin.ch 01/01/2017
Christoph Gerber

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Arbeitsspeicher auf Energiediät: Forscher entwickeln Grundlage für neuartigen Speicherchip

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Basel Physicist Daniel Loss Receives the King Faisal International Prize

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Le physician Suisse Daniel Loss recoit le Prix Roi Faisal 2017

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Physiker Daniel Loss erhält König-Faisal-Preis

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Basel physicist Daniel Loss receives the King Faisal International Prize

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Basel physicist Daniel Loss receives the King Faisal International Prize

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Forschern aus Dresden und Basel gelingt Durchbruch

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Der nächste Schweizer Nobelpreisträger?

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About this publication

Concept and layout: Christel Möller
Texts: Christel Möller, Christian Schönenberger
Translations: Uniworks, Erlangen, Germany
Print: Publikation Digital, Biel, Switzerland

Images:

Cover:	The beauty of foam, REM image taken during a block course at the NI Lab (C. Mattle, student nanosciences)
Page 5:	SNI Director Prof. Dr. Christian Schönenberger (C. Möller, SNI)
Page 8–9:	3D structure of ASC inflammasome (combination of cryo-electron microscopy and NMR spectroscopy) (L. Sborgi, Biozentrum, University of Basel)
Page 11:	Prof. Dr. Andrea Schenker-Wicki, President of the University of Basel (C. Möller)
Page 15:	Prof. Dr. Daniel Müller, Department of Biosystems Science and Engineering (D-BSSE) ETH Zurich in Basel (C. Möller)
Page 16:	King Salman of Saudi-Arabia honors Professor Daniel Loss (King Faisal International Prize)
Page 18 :	Award ceremony of the King Faisal International Prize 2017 (King Faisal International Prize)
Page 19:	Prof. Dr. Daniel Loss (University of Basel)
Page 20–21:	Leg of *Drosophila melanogaster*, REM image taken during a block course at the NI Lab (C. Mignani, J. Koechlin, and C. Küng)
Page 23:	Elise Aeby, former nanoscience student and winner of the best Master's thesis in nanoscience 2016 (C. Möller)
Page 24:	Dr. Adrian Najer, former doctoral and nanoscience student at the University of Basel (T. Angus, Imperial College London)
Page 26:	Claudia Mignani and Julian Koechlin, 5th-semester nanoscience students, and Evi Bieler of the Nano Imaging Lab (C. Möller)
Page 29:	Belly of a head louse, REM image taken during a block course at the NI Lab (C. Mattle)
Page 30–31:	Nanopocket inside a nanochannel on a glass substrate (D. Sharma, Paul Scherrer Institute)
Page 33:	Dr. Stefan Arnold, former SNI PhD student and currently Junior Project Manager at Sensirion AG (C. Möller)
Page 36:	Dr. Tomaž Einfalt, former SNI PhD student and currently PostDoc at the Department of Pharmeceutical Sciences, University of Basel (C. Möller)
Page 39:	Dr. Michael Gerspach, former SNI PhD student and currently Research Scientist at BÜHLMANN Laboratories AG (C. Möller)
Page 42–43:	Nuclear pore complex component and the transport receptor (B. Huang, Biozentrum)
Page 44:	Argovia-Professor Dr. Martino Poggio and SNI doctoral student Davide Cadeddu (C. Möller)
Page 48:	Argovia-Professor Dr. Roderick Lim (C. Möller)
Page 50–51:	Test structure for a medical tool (Armin Stumpp, FHNW)
Page 53:	Claudio Schmidli and Luca Rima, doctoral students at C-CINA and members of the Nano Argovia project MiPIS (C. Möller)
Page 57:	Agnese Carino, doctoral student at PSI and member of the Nano Argovia project CerInk (M. Fischer, Paul Scherrer Institute)
Page 58–59:	Pollen of *Babiana framesii* (D. Mathys, Nano Imaging Lab, SNI)
Page 61:	Corundum with glass-filled cracks (E. Bieler, Nano Imaging Lab, SNI)
Page 63:	Tooth of *Homo erectus* (E. Bieler, Nano Imaging Lab, SNI)
Page 67:	Professor Dr. Philipp Treutlein and Dr. Peter Reimann in front of the colorful conduits used for the optical fiber network (C. Möller)
Page 68–69	The busy SNI booth at the tunBasel (C. Möller)
Page 70:	Students of the 'Alte Kantonsschule Aarau' experiment during the TecDays (C. Möller)
Page 73:	Students of the 'Alte Kantonsschule Aarau' experience the challenges of living with Parkinson's (C. Möller)
Page 75:	Examples of the new SNI website (nanoscience.ch)
Page 76–77:	GaAs Hall bar with resist residues (M. Rehmann, Physics Department, University of Basel)
Page 78–79:	Crystalline contaminations on diamond (M. Batzer, Physics Department, University of Basel)

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