University of Basel

Swiss Nanoscience Institute

SNI

Swiss Nanoscience Institute
Center of Excellence supported by the University of Basel and the Canton of Aargau

Annual Report Swiss Nanoscience Institute

Scientific supplement
Scientific reports from the Nano-Argovia and SNI PhD School projects from 2024 can be found on our website or by scanning the QR code.

bit.ly/3WL7A4P

www.nanoscience.ch
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Dear colleagues and nanoenthusiasts,

In the Annual Report 2024 that you have before you, we look back over a busy year that was full of fascinating research findings and events that provided opportunities for inspirational encounters. It was also a year in which we continued to think intensively about the future of the Swiss Nanoscience Institute as we prepared the final draft of the strategy paper for 2024–2034. To this end, we not only sought the advice of external experts but also took up ideas and proposals from within the SNI network. In May 2024, the paper was then approved by our highest body, the Argovia Committee. Accordingly, it will now serve as a guide and help us fulfill our vision of using nanotechnology to improve lives. As the network for nanosciences in Switzerland, we are keen to help tackle the challenges of the future through education and research. Our focus will be on nanoimaging and nanofabrication and on bolstering collaboration within the network. We will make sensible and necessary adjustments on an ongoing basis and help solve the challenges facing society through our activities in the areas of teaching, research, technology transfer and services.

In the first section of the annual report, we showcase selected highlights in terms of education within the nanosciences degree program and at the SNI PhD School before taking a closer look at research findings. Here, we offer examples of the fields where members of the SNI network have published their results in renowned scientific journals. We also provide short and succinct descriptions of applied research projects funded by the SNI as part of the Nano-Argovia program in 2024. In this context, it's always fascinating to see the diverse approaches adopted by nanoscience research in its mission to deliver solutions. This year, researchers have tackled problems in the life sciences, medicine, and environmental, materials and quantum science – that is, in precisely the areas where we want to continue making valuable contributions in the future by visualizing and manufacturing tiny structures and objects.

The Nano Imaging Lab and Nano Fabrication Lab are the two service units that together make up the Nano Technology Center. These two units contribute to the SNI's success not only through their services but also through research of their own. Over the coming years, the two teams will play an increasingly vital role within our network and act as a link between researchers. Work relating to nanoimaging and nanofabrication is not only of interest to scientists. Indeed, an ever-broader audience enjoys fascinating insights into the micro and nanoworld courtesy of the staff of the Nano Technology Center.

Our small, dedicated communication and outreach team also generates interest in the natural sciences in general and the nanosciences in particular on an ongoing basis with the help of various events, such as the hugely successful "TecDay meets Swiss NanoConvention" in 2024. For this event, which formed part of the Swiss NanoConvention organized by the SNI in Basel, our team worked with the Swiss Academy of Engineering Sciences SATW to compile a special program for 60 students from Swiss high schools. The program provided the students with an introduction to the nanosciences as well as a chance to experience the exciting atmosphere of an international scientific conference.

This annual report provides further information on all of our activities. For example, a series of images offer insights into the work of various working groups that together make the SNI a unique interdisciplinary, interinstitutional network with shared objectives.

For those who want more information, the scientific supplement offers more-detailed descriptions of projects supported as part of the SNI PhD School and the applied Nano-Argovia program in 2024.

We hope you enjoy reading this year's report.

Kind regards,

Professor Martino Poggio
SNI Director

2024 in brief

Completed master's studies
Thirteen students successfully completed the challenging master's program in nanosciences in 2024.
Page 13

Alumni organization resumes activities
After a prolonged hiatus, the board of the alumni organization met again in late 2024 and already organized one meeting for members in December 2024.
Page 13

Excellent dissertations
Seven SNI PhD students completed their doctoral dissertations in 2024, having carried out their corresponding research at the Biozentrum and the Departments of Chemistry and Physics of the University of Basel, at the Paul Scherrer Institute, and at the FHNW School of Life Sciences.
Page 16

Startup workshop
In 2024, the workshop "From Lab to Startup" was incorporated into the regular program of the SNI PhD School. From now on, this annual course will provide doctoral students with an introduction to the world of founding a company.
Page 21

Valuable support
In 2024, the two teams that make up the Nano Technology Center – that is, the Nano Imaging Lab and the Nano Fabrication Lab – supported numerous research groups by providing services relating to the imaging and fabrication of micro and nanostructures. By doing so, the staff make a key contribution to successful research.
Page 50

In 2024, the team of the Nano Imaging Lab began operating a new scanning electron microscope with a focused ion beam.

Strategy for the next 10 years
In 2024, the SNI team worked with external and internal experts to develop its strategy for 2024–2034. The SNI will focus on nanoimaging and nanofabrication in the life sciences, medicine, and materials, quantum and environmental science. Collaboration within the network will be strengthened, and the infrastructure, curriculum and public image will be adapted and modernized. Through basic and applied research and the training of committed young scientists, the SNI will drive advances for the benefit of the general public.
Page 61

In 2024, Aris Lafranca received the prize for the best master's thesis in nanosciences at the University of Basel.

Our honorary member Christoph Gerber was added to the list of Clarivate Citation Laureates for his significant contributions to the nanosciences.

Elizaveta Maksimova won the prize for the best pitch as part of the "From Lab to Startup" workshop.

Numerous opportunities for networking

By organizing the Swiss NanoConvention, the Annual Event and the NanoTec Apéro, the SNI team provided its members with numerous opportunities for interdisciplinary exchange across institutional boundaries.

Page 62

Method for detecting nanoparticles in early life nutrition

As part of the Nano-Argovia program, researchers developed a technique for detecting nanoparticles in baby food.

Page 26

Nanocompartments for enzymatic reactions

Scientists from the SNI network presented novel nanoclusters inspired by the way natural cells interact in tissue.

Page 27

Nanostructures for better implants

As part of the Nano-Argovia program, researchers demonstrated how nanostructured titanium surfaces (Ti2 spikes) can contribute to improved dental implants.

Page 27

Coupling of nanowire and ions

As part of a doctoral dissertation at the SNI PhD School, researchers combined a nanowire with cooled ions and specifically set the ions in motion using mechanical vibrations of the nanowire. In the future, this could pave the way for the development of hybrid quantum systems.

Page 30

Friction depends on speed

Researchers from the SNI network showed that, on the nanometer scale, frictional forces depend on speed.

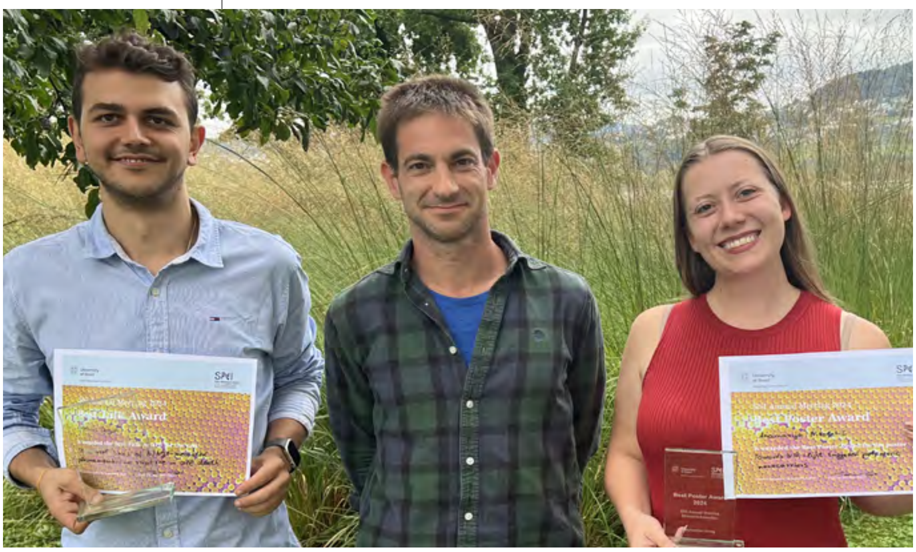
Page 31

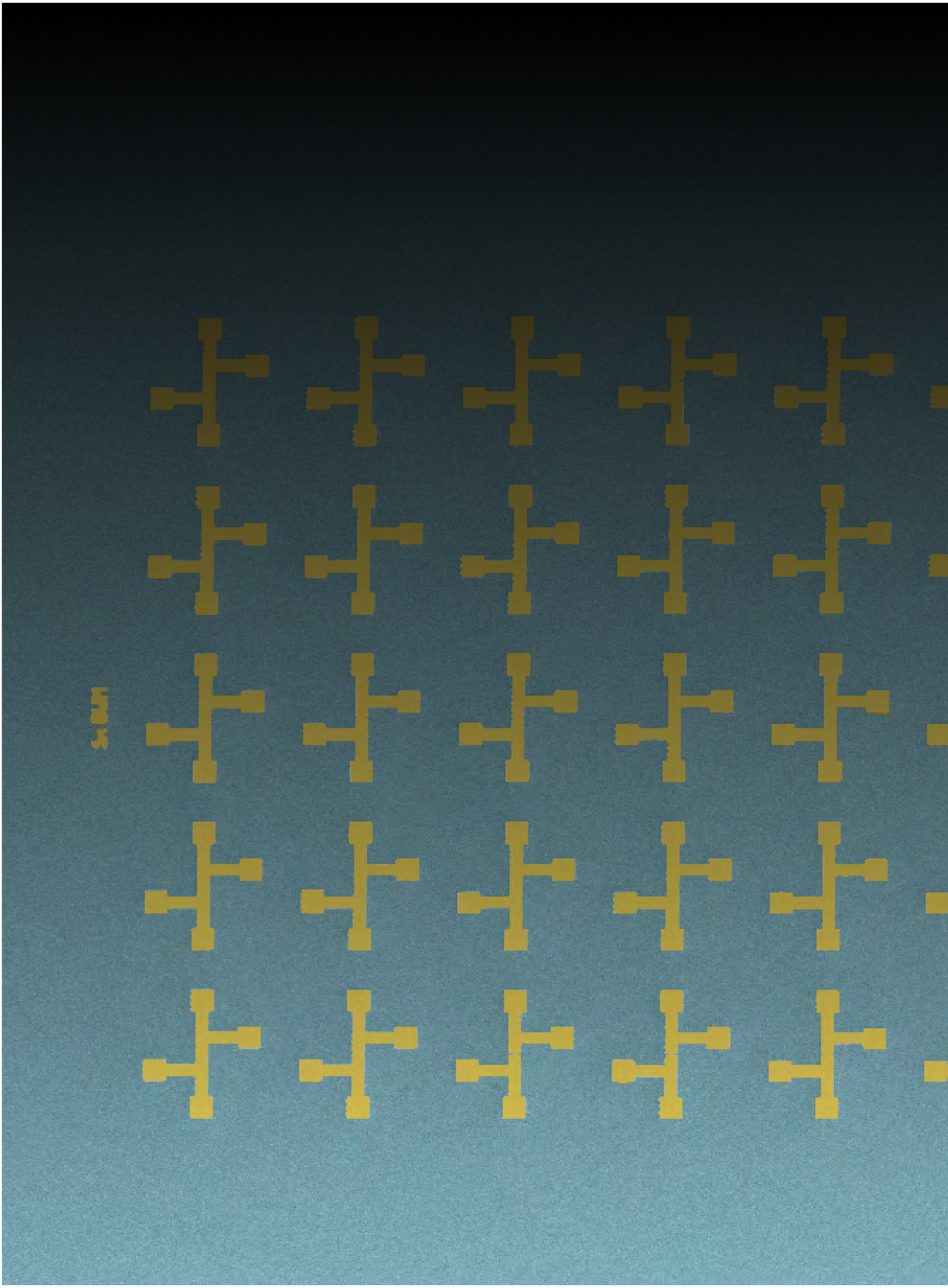
Strong spin-photon coupling

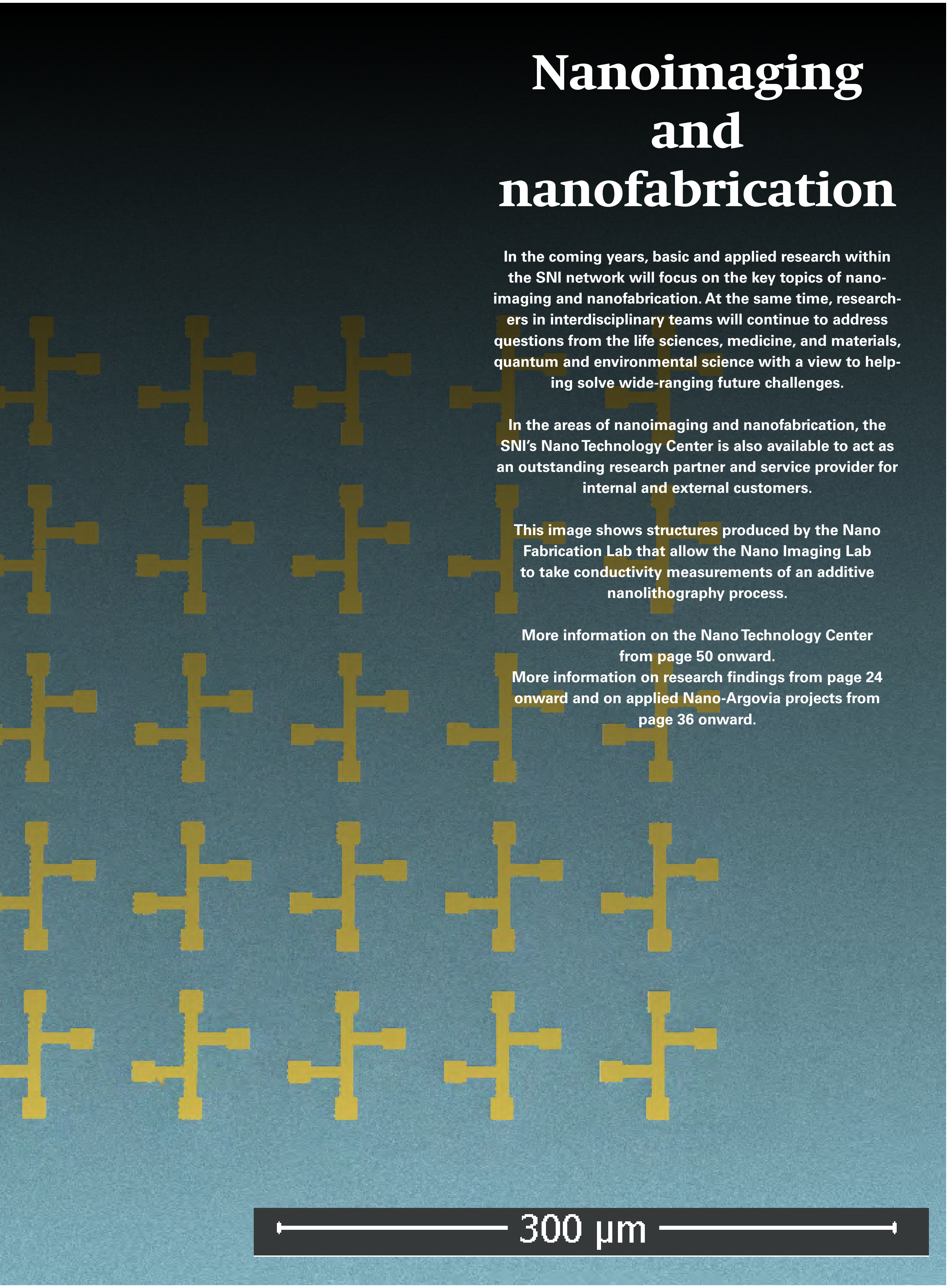
Researchers from the SNI network achieved strong coupling between an electron spin and a single photon. Normally, an electron spin couples only weakly to photons.

Page 32

In 2024, the SNI Annual Event was again held in the Canton of Aargau. Anamarija Nikoletić (right) received an award for the best poster, and Morris Degen (left) won the prize for the best talk.







Nanoimaging and nanofabrication

In the coming years, basic and applied research within the SNI network will focus on the key topics of nanoimaging and nanofabrication. At the same time, researchers in interdisciplinary teams will continue to address questions from the life sciences, medicine, and materials, quantum and environmental science with a view to helping solve wide-ranging future challenges.

In the areas of nanoimaging and nanofabrication, the SNI's Nano Technology Center is also available to act as an outstanding research partner and service provider for internal and external customers.

This image shows structures produced by the Nano Fabrication Lab that allow the Nano Imaging Lab to take conductivity measurements of an additive nanolithography process.

More information on the Nano Technology Center from page 50 onward.
More information on research findings from page 24 onward and on applied Nano-Argovia projects from page 36 onward.

Swiss Nanoscience Institute: The interdisciplinary center of excellence for nanosciences in Northwestern Switzerland

The Swiss Nanoscience Institute (SNI) was founded in 2006 by the Canton of Aargau and the University of Basel and brings together researchers from leading scientific institutions from Northwestern Switzerland that are dedicated to questions of both basic and applied science. At the same time, the SNI plays an active role in training young scientists in order to ensure that the experts of the future are ideally prepared to tackle interdisciplinary challenges.

Key to this intensive commitment is Switzerland's only nanoscience degree program, which leads students to a bachelor's and master's degree in nanosciences at the University of Basel. The SNI also operates an international PhD School, which attracts talented early career researchers from across the world.

Research and teaching are supported by the Nano Technology Center, which provides academic and industrial partners with expertise in the areas of imaging, analysis and micro and nanofabrication through the two service units — the Nano Imaging Lab and the Nano Fabrication Lab.

In the future, the SNI will increasingly orient its research activities toward the areas of nanoimaging and nanofabrication. Through close collaboration within the network, the SNI will help to tackle pressing challenges in the life sciences, medicine, and quantum, materials and environmental science.

24%

24% of SNI members are women.

11+13+7

In 2024, eleven students successfully completed their bachelor's program, thirteen completed the master's program. Seven doctoral students successfully defended their PhD theses.

40

In 2024, 40 doctoral students were enrolled in the SNI PhD School.

173

173 members belong to the SNI network. (PIs, PhD students, management, Nano Fabrication Lab, and Nano Imaging Lab).

50

In 2024, 50 research projects were running, 10 in the applied Nano-Argovia Program and 40 in the SNI PhD School.

76

In 2024, 52 students were enrolled in the bachelor's program and 24 in the master's program.

73+130

In 2024, the Nano Fabrication Labs had 73 different users. The Nano Imaging Lab received more than 180 orders, which often take several days, from 130 different customers.

17

Seventeen of the 60 doctoral students who had completed their PhDs by the end of 2024 work at a federal or research institution.

40

Forty of the 60 doctoral students who had completed their PhDs by the end of 2024 work in industry.

74

In 2024, a total of 74 peer-reviewed papers with participation of SNI members were published in renowned science journals.

.

10

There are ten partner institutions in the SNI network. These include the research institutions University of Basel, the School of Life Sciences and the School of Engineering and Environment at the University of Applied Sciences and Arts Northwestern Switzerland FHNW, the Paul Scherrer Institute PSI, the Centre Suisse d`Electronique et de Microtechnique (CSEM) in Allschwil, the Department of Biosystems Science and Engineering at the ETH Zurich in Basel, and the technology transfer centers ANAXAM and Swiss PIC. The network also includes the Hightech Zentrum Aargau and Basel Area Business & Innovation.

8.9 M

In 2024, the SNI had expenditures of approximately CHF 8.9 million (without building costs) of which CHF 5.8 million were covered by the Canton of Aargau and CHF 3.1 million by the University of Basel.

>7000

The SNI social media channels on Instagram, LinkedIn, X, Bluesky and YouTube have more than 7000 followers.

The SNI is funded by the Canton of Aargau and the University of Basel.

Rooted in the Canton of Aargau and the University of Basel

The SNI was founded in 2006 by the Canton of Aargau and the University of Basel in order to drive forward research and training in the nanosciences and nanotechnology in Northwestern Switzerland. In the coming years, the plan is to focus on nanoimaging and nanofabrication with a view to contributing to new insights and innovations in the life sciences, medicine, and quantum, materials and environmental science.

Nanotechnologies play a key role in research and industry in the Canton of Aargau. The SNI's numerous research projects provide companies from Aargau, Solothurn and the two Basel half-cantons with access to new scientific findings and innovative technologies and services.

In 2024, the SNI spent approximately 8.9 million Swiss francs, of which some 5.8 million were provided by the Canton of Aargau and 3.1 million by the University of Basel.

The SNI brings together researchers from the leading scientific institutions of Northwestern Switzerland.

Interdisciplinary network

The SNI interconnects researchers from leading scientific institutions in Northwestern Switzerland, including various departments of the University of Basel; the University of Applied Sciences Northwestern Switzerland, with its School of Life Sciences in Muttenz and School of Engineering and Environment in Windisch; the Paul Scherrer Institute PSI; the Department of Biosystems Science and Engineering at ETH Zurich in Basel; the Centre Suisse d'Electronique et de Microtechnique (CSEM) in Allschwil; and the two technology transfer centers ANAXAM and Swiss PIC. The SNI also engages in collaborations with the Hightech Zentrum Aargau in Brugg and with Basel Area Business & Innovation in relation to knowledge and technology transfer.

Providing training and support for early career researchers is one of the key tasks of the SNI.

Education and career advancement

In the bachelor's and master's program in nanosciences at the University of Basel, students receive a comprehensive grounding in the natural sciences before specializing in individual focal areas. From an early stage, the students gain practical experience in research groups and familiarize themselves with industrial projects.

So far, a total of 296 students have earned a bachelor's degree in nanosciences in Basel, and 229 students have successfully completed the nanosciences master's program. At the end of 2024, there were 52 students enrolled on the bachelor's program and 24 early career researchers enrolled on the master's program.

For many young nanoscientists, the master's degree is followed by a doctoral dissertation. Some former nanoscience students at the University of Basel go on to complete their dissertation at the SNI PhD School, which was founded in 2012, but most of the 40 doctoral students who formed part of the SNI PhD School in 2024 had completed their previous education at foreign universities. The students generally work on questions of basic research, which are often interdisciplinary in nature. Seven doctoral students successfully completed their dissertation in 2024, while six new projects were approved and will start in 2025. Over 70% of the 60 graduates of the SNI PhD School remain in Switzerland after completing their dissertation.

Support for research groups

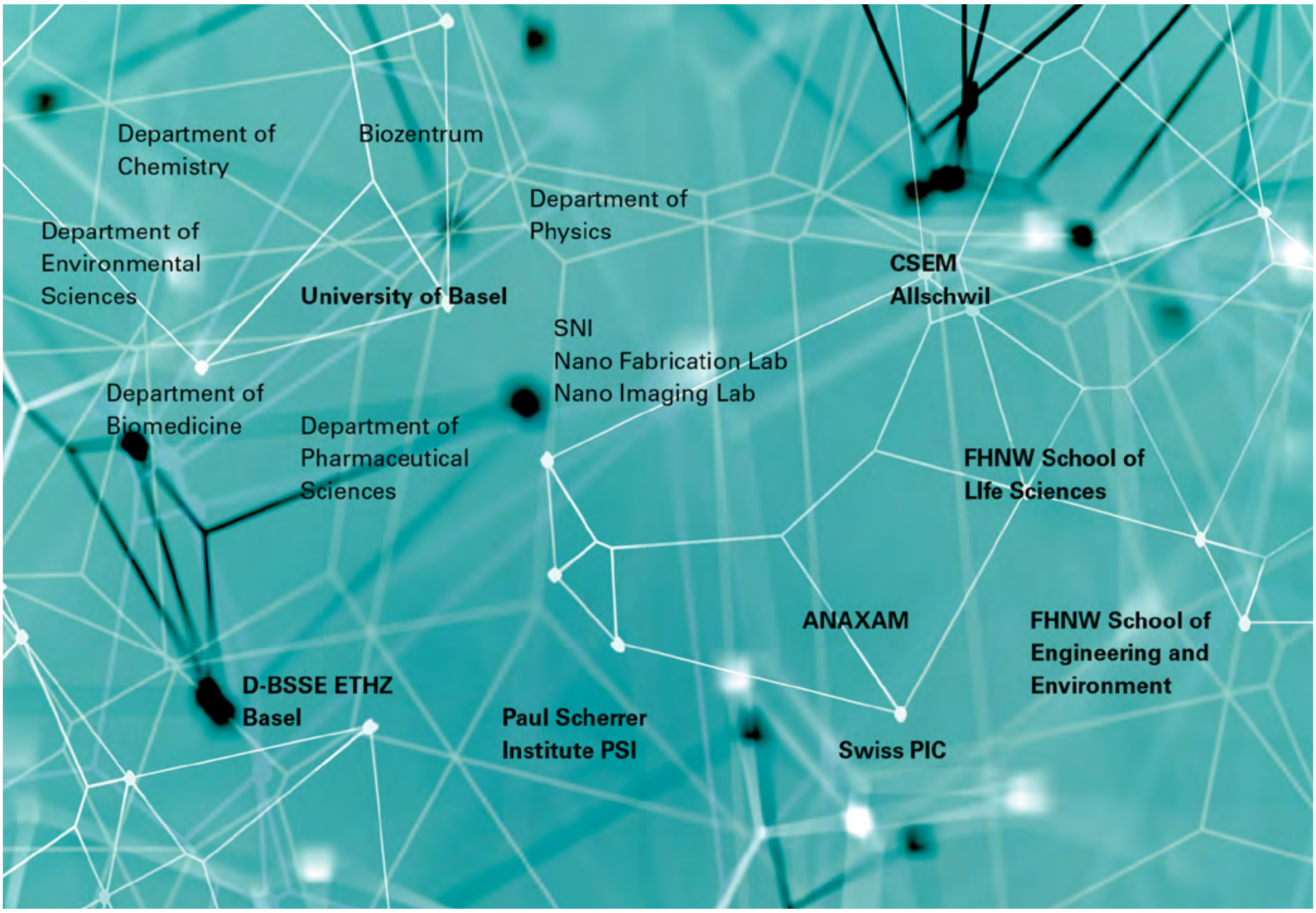
The two SNI-supported Argovia professors Roderick Lim and Martino Poggio are very active in training and in their respective areas of research with their research groups at the University of Basel. Through their work on cellular transport processes and nanomechanics and nanomagnetism, respectively, they make a significant contribution to the SNI's outstanding reputation. In addition, the SNI funds the research of the three titular professors Thomas Jung, Michel Kenzelmann and Frithjof Nolting, who lecture at the Department of Physics of the University of Basel and are active with their research groups at PSI.

Technology transfer and industrial collaborations

The SNI supports knowledge and technology transfer through the Nano-Argovia program, in which around 100 projects have already been carried out in collaboration with companies from Northwestern Switzerland. In 2024, 10 of these applied research projects received financial support. Six of the partner companies hailed from the Canton of Aargau, while four were based in one of the two Basel half-cantons. Collaboration with industry is also supported by the two technology transfer centers ANAXAM and Swiss PIC, which are also partners in the SNI network.

Highly qualified services from the Nano Technology Center

The SNI's Nano Technology Center provides specialized services to research and industry through its two groups – the Nano Imaging Lab (NI Lab) and the Nano Fabrication Lab (NF Lab). In the NI Lab, the six-person team specializes in surface imaging and analysis, while the four members of the NF Lab provide access to extensive instrumentation and clean rooms, offering researchers within the network and beyond the opportunity to produce tiny structures on the micro and nanoscale.



The interdisciplinary network of the SNI is made up of research groups from the leading research institutions in Northwestern Switzerland. These research groups work on basic and applied research projects, ensure an excellent standard of research work, and are committed to the training of early career researchers. (Background image: iStock)

In the focal areas of nanoimaging and nanofabrication, the Nano Technology Center acts as a service unit and research partner, providing valuable support for wide-ranging research projects.

Public relations and science communication

It's important to the SNI team not only to train young scientists, conduct excellent research and act as a sought-after partner and service provider, but also to inform the general public about SNI activities and foster an interest in the natural sciences.

As part of science festivals, exhibitions and markets, as well as through laboratory tours and collaborations with adult education centers or other institutions, SNI staff seek to engage with various target groups. Through individual formats, which are almost always associated with interactive activities, the SNI team opens the door to the world of tiny structures and objects, generating interest in nanoresearch. The communication team also collates information in the form of videos, brochures, media releases and an online magazine that reach the different target groups via various social media channels.

Nanoscience program: Varied, challenging and more topical than ever

Aspects of the nanosciences feature in interdisciplinary fields such as the life sciences, materials, environmental and quantum sciences, as well as medicine. Studying nanosciences at the University of Basel leaves students ideally prepared to handle wide-ranging tasks in these and other disciplines, equipping them to solve the challenges that will face our society in the future.

In the introductory level, students gain a solid grounding in the natural sciences, which they then consolidate as they become increasingly specialized over the course of their bachelor's and master's studies. To that end, the young scientists choose two from the following specializations as part of the master's program: medical nanosciences, molecular biology, nanochemistry and nanophysics. At the same time, students continue to benefit from the interdisciplinary nature of the degree program, providing them with insights into wide-ranging research problems and methodology. This teaches budding researchers the "languages" of various disciplines and provides them with the ideal tools to work at the interface between different subject areas.

In 2024, there were 52 students enrolled on the bachelor's program and 24 on the master's program. Eleven students successfully completed their bachelor's studies, and 13 obtained a master's degree.

For the last few years, the grand finale of the nanosciences program at the University of Basel has been the master's degree ceremony at Wildt'sches Haus. (Image: K. Schad)

Active again
Nanosciences alumni organization

The COVID-19 pandemic imposed significant restrictions on all kinds of social activities, and we haven't yet returned to pre-pandemic levels across the board. Restrictions also affected the nanosciences alumni organization, which has now resumed its activities after this forced hiatus.

In fall 2024, the members of the board met once again to put together a program for the coming months. A first "AlumniNano meets @Basel" event was held at Markthalle Basel in December 2024 and was attended by almost 40 former and current nanoscience students, providing them with a chance to revive old contacts and make new ones. The numerous further events the board members have planned for 2025 will help to rekindle the sense of community and mutual support between graduates of the nanoscience program and the SNI PhD School, ensuring that everyone enjoys the benefits of a lively network.

AlumniNano organization: https://bit.ly/3VyhKG5

After a rather long break, the board of the AlumniNano organization has re-formed and created a program for the coming months. (Picture: AlumniNano)

An excellent master's thesis
Aris Lafranca investigates a hybrid resonator

In 2024, Aris Lafranca received the prize for the best master's thesis in nanosciences at the University of Basel. As part of his winning thesis at the Department of Physics, the young nanoscientist from Ticino investigated a hybrid resonator in greater detail. Made of hexagonal boron nitride and a silicon nitride membrane, this resonator could potentially be used to measure forces, masses or acceleration, as well as for biomedical applications. Lafranca's investigations sought to better characterize the system and to monitor and control the influence of temperature.

Report on Aris Lafranca's master's thesis:
https://bit.ly/4grLNGh

Video with Aris Lafranca:
https://youtu.be/UhcM43AK-7s

**"Aris' thesis is without a doubt the best and most expertly executed master' thesis I have read here in Basel.
I am very pleased that he has decided to continue working in experimental physics as a PhD student in my group."**
Prof. Martino Poggio,
Department of Physics,
University of Basel

Argovia Travel Grants
Valuable experience for students

Nanoscience students can apply for Argovia Travel Grants if they are planning to complete project work or a master's thesis abroad. Spending time in an international research environment gives them access to highly specialized laboratories, technologies and research groups that complement the opportunities on offer in Basel. Students familiarize themselves with new methods and start to build up a global scientific network, gaining international experience that not only drives their academic development but also boosts personal skills such as adaptability, intercultural communication and independence.

In 2024, four students benefited from the offer of financial aid in the form of Argovia Travel Grants. Three of them have since completed their projects, having worked at the Department of Biomaterials & Biomedical Technology and the European Research Institute for the Biology of Ageing at University Medical Center Groningen (NL) and at the Department of Chemical Engineering and Biotechnology at the University of Cambridge (UK). One master's student is still working at the Institute for Technology-Inspired Regenerative Medicine of the University of Maastricht (NL) and will complete her master's degree in 2025.

Reports from students on their time abroad:
https://bit.ly/3Jss64m

"I'm grateful to the Swiss Nanoscience Institute and Professor Santos for this amazing opportunity. As well as gaining knowledge and practical experience, I discovered new avenues of professional and personal development — and had a great time in Groningen, both inside and outside the laboratory."
Alexa Dani, a former nanoscience student who wrote her master's thesis at University Medical Center Groningen in the Netherlands and now works at Roche in Basel

"During my time in Cambridge, I was able to practice and improve my skills in the areas of scientific planning, discussion and criticism, as well as interpersonal communication. I also benefited from a highly supportive and motivational working environment, which gave me the opportunity to build friendships with people from all over the world and expand my scientific network."
Michelle Arnet, a former nanoscience student who completed her master's thesis at the Department of Chemical Engineering and Biotechnology at the University of Cambridge (UK) and is now doing a doctorate at the German Cancer Research Center in Heidelberg (Germany)

Students carry out small projects of their own within the framework of the block courses. This provides them with an insight into current research at various departments of the University of Basel and other research institutions from the SNI network.

Block courses
A first foray into the world of research

In the fifth and sixth semesters of the bachelor's program, nanoscience students complete eight internships, each lasting one to three weeks, in wide-ranging research groups within the SNI network. In 2024, students had 40 of these multidisciplinary block courses to choose from, giving them a unique opportunity to familiarize themselves with different research institutions and participate actively in current research projects for the first time. These intensive modules combine theoretical knowledge with practical research problems and provide participants with first-hand insights into the latest technologies and methodologies.

At the end of the sixth semester, the students organize a small one-day conference of their own to conclude the block-course program. Beforehand, they are given information on event organization, corporate design, storytelling and presentation techniques so that they are well prepared to present results from the courses to an interdisciplinary committee of researchers in the form of a poster and a presentation.

The block courses have become an established key element of training at the SNI and are a vital step in ensuring that the next generation of nanoscientists are ideally prepared for the challenges of research and industry.

+ Information on the block courses: https://bit.ly/3QrKOeV

SNI PhD School Specialization with an insight into various fields

A key part of the Swiss Nanoscience Institute’s mission is to train excellent young nanoscientists who are capable of working at the interfaces between various disciplines in order to tackle the challenges of the future.

Founded in 2012, the SNI PhD School ensures that, every year, it turns out early career researchers who are not only specialists in their subject area but also have a broad understanding of topics outside their own discipline. This is achieved through a combination of the interdisciplinary events of the SNI network and courses developed specially for the SNI PhD School. In 2024, the revised “From Lab to Startup” workshop also featured in the program for the first time, giving doctoral students the chance to experience the first steps in founding a startup based on specific concepts that they developed themselves.

A total of 40 doctoral students were enrolled in the SNI PhD School in 2024, almost 25% of whom were women. Seven doctoral students successfully completed their doctoral dissertations in 2024. Six new dissertation projects were approved in 2024 and will begin in 2025.

Of the 60 SNI doctoral students who have completed their dissertations so far, around 70% were employed in industry at the end of 2024. In addition, almost 30% of former SNI doctoral students are employed at research institutions or federal offices.

Melissa Carrillo worked on her doctoral thesis at the Paul Scherrer Institute and is now a postdoctoral researcher at Northwestern University in Chicago IL (USA).

Annika Huber completed her doctoral thesis at the Department of Chemistry at the University of Basel.

Maria-Elisenda Alaball Pujol conducted research for her doctoral thesis at the Biozentrum of the University of Basel.

Novel sample carrier for crystallographic investigations

In her doctoral dissertation, Dr. Melissa Carrillo developed and tested a new type of polymer sample carrier that is ideally suited for investigating protein crystals at synchrotron and X-ray free-electron laser sources.

A transparent micro-structured polymer membrane equipped with thousands of pyramid-shaped indentations with tiny holes at their bottom serves as the sample carrier. During sample deposition, the protein crystals to be analyzed self-align in these 100 x 100 µm^2 cavities, allowing their position to be determined prior to analysis. The sample carrier is characterized by minimal background signal, user-friendly handling, durability and high reusability. It also offers the potential for cost-effective mass production.

In her work, Melissa also produced an opaque version of the carrier for experiments with light-responsive proteins. Using these carriers she has analyzed ligand binding of a light-driven system to uncover the structural dynamics of binding events.

Publication: https://bit.ly/3WefdQX

Sensor for gas-phase molecules

In her doctoral dissertation, Dr. Annika Huber developed a nanomaterial that can be used as a sensor for certain gas-phase molecules – specifically, asymmetric molecules that have the same chemical formula but whose reflections are non-superimposable. These “enantiomers” have the same physical properties but rotate polarized light in different directions (clockwise and counterclockwise). Since their biological modes of action can be very different, it is important to detect the two enantiomers separately from one another – which is difficult given their similarity.

The nanomaterial developed by Annika Huber consists of square-planar platinum complexes, which are known for their tendency to form stacked aggregates with short metal–metal distances. This can result in one-dimensional nanostructures that exhibit high electrical conductivity, vapochromism and photoluminescence. By modifying the platinum complexes, Annika induced asymmetric stacking that responded differently to the counterclockwise or clockwise form of the molecule pairs under analysis. Based on five tested pairs, she succeeded in showing that the platinum complexes can, in principle, be used as an enantiospecific sensor. This could, for example, allow her to detect specific climate-relevant terpenes from the atmosphere.

Video: https://youtu.be/8JxTRe8rRPo

Microfluidics for antibiotics research

As part of her doctoral dissertation, Dr. Maria-Elisenda Alaball Pujol has developed an integrated microfluidic system that can be used to quantify how bacteria response to different antibiotics depending on their physiological state. The method allows the identification of antimicrobial compounds that can be used specifically to target resistant subpopulations and supplement existing treatments.

For her investigations, Maria-Elisenda has further developed and used an integrated microfluidic and computer-aided setup (dual-input Mother Machine). Here, the bacteria grow in narrow growth channels that run perpendicular to a main channel. The bacteria can be supplied with different media under adjustable conditions. The supply of various antibiotics can also be precisely controlled. The image analysis software Mother Machine Analyzer enables the monitoring of bacterial cells over time. Maria-Elisenda has developed new microfluidic circuits that allow testing several antibiotics and bacterial strains in parallel. With this new technology, she was able to track single bacteria before, during and after antibiotic administration and evaluate their survival. For the investigations, she focused on the treatment of *Escherichia coli* with a number of clinically relevant antibiotics.

Gian-Luca Schmid completed his doctoral thesis at the Department of Physics at the University of Basel and continued his work there as a postdoctoral researcher.

Moritz Weegen completed his experimental work at the Departments of Chemistry and Physics of the University of Basel. He is currently working as a data engineer at IWB.

Josh Zuber completed his doctorate at the Department of Physics of the University of Basel, where he continued working as a postdoc.

Coupled with light

In his doctoral dissertation, Dr. Gian-Luca Schmid used laser light to couple two different quantum systems over a relatively large distance of one meter. Interfaces of this kind are vital for future quantum technologies.

For the microscopic system, Gian-Luca Schmid used the collective spin of a cloud of cold rubidium atoms, while the macroscopic system was a vibrating membrane positioned between two mirrors. The membrane had a nanostructure that optimized the vibrational properties.

Gian-Luca used the interaction between the two systems to cool the mechanical oscillator down to a temperature close to absolute zero within a fraction of a second. This process involves first aligning the intrinsic angular momentums (spins) of the atoms in a well-defined direction, a situation that corresponds to a very cold state, close to absolute zero. Since the two systems are coupled, the membrane – which is at room temperature and therefore vibrating strongly – transfers its energy to the atoms. These atoms are then quickly returned to their initial state using laser light. This principle of coherent feedback, in which the atomic spin acts as a control unit for the oscillator, works without the need for measurements that would influence the system.

⊕ Publication: https://doi.org/10.1103/PhysRevX.12.011020

Video: https://youtu.be/gWER3ToDqNo

Coupling a solid body to an atomic system

For his doctoral dissertation, Moritz Weegen developed and then characterized a hybrid system consisting of a solid body and a small number of atoms.

He achieved this by coupling a charged nanomechanical oscillator in the form of a silver-gallium nanowire (Ag^2Ga) to individual calcium ions (Ca^+) caught in a high-frequency trap. This creates a hybrid system in which the calcium ions can be excited by mechanical motion of the nanowire. In his experimental work, Moritz Weegen showed that the strength of coupling depends on various parameters, such as the mechanical properties and oscillation amplitude of the nanowire, the distance between the nanowire and the ions, and the nanowire's charge. To support these experimental findings, he developed a theoretical model of the hybrid system and performed simulations describing the interaction in classical terms.

Hybrid systems of this kind, consisting of a solid body and an atomic system, exploit the benefits of both coupled systems and promise to deliver new applications in quantum technology and quantum communication.

⊕ Publication: https://doi.org/10.1103/PhysRevLett.133.223201

Sensitive sensors based on diamond color centers

For his doctoral dissertation, Dr. Josh Zuber studied silicon vacancy centers in diamonds with a view to potential applications in scanning probe magnetometry. These diamond color centers are particularly interesting because they exhibit excellent optical and spin properties even under extreme conditions, as well as possessing outstanding photostability.

Josh Zuber's work showed that, thanks to their high spatial resolution and sensitivity, negatively charged silicon vacancy centers in optimized nanostructures (SiV^-) were suitable for studying complex physical systems whose analysis is only possible in extremely low temperatures (<-272.15°C) and strong magnetic fields. Further analyses showed that even the neutral silicon vacancy centers (SiV^0) in diamonds represent promising candidates for quantum technology applications. In his thesis, Josh Zuber presented a new method for controlling the charge state of SiV centers, including surface treatment and optical techniques for switching between the SiV^- and SiV^0 charge states. His work represents a key contribution to the use of SiV centers for precise measurements under extreme conditions and offers new methods for controlling diamond color centers, thereby paving the way for advanced quantum technologies in quantum sensing, quantum computing and quantum communication.

⊕ Publication: https://doi.org/10.1021/acs.nanolett.3c03145

Fabian Züger carried out his experimental work at the FHNW School of Life Sciences.

Replacement tissue for the heart

In his doctoral dissertation, Dr. Fabian Züger developed a promising strategy to produce replacement heart tissue that mimics the structures and characteristics of the cardiac muscle.

As a base material, he developed a tailor-made bioink made of methyl cellulose and gelatin that contained myocardial cells from rats and showed excellent printing properties. The ink could be used to print up to 5.4 million cells per millimeter and to configure the stiffness in order to mimic the various tissue types, including the cardiac muscle. Fabian Züger also used electrospinning to produce fine, conductive, tailor-made nanofibers comprising a mixture of carbon nanotubes and polycaprolactone, delivering a combination that mimicked the natural extracellular matrix of the heart.

In Fabians's investigations, over 90% of the printed cardiac muscle cells survived. After just five to eight days, the cells began to contract spontaneously – which is normal and desirable behavior for heart cells. The conductive nanofibers had a positive influence on the control of such cells.

This system successfully combines the benefits of 3D bioprinting and electrospinning, offering an innovative method for the production of cardiac tissue for research and potential applications in regenerative medicine.

Publication: https://doi.org/10.3390/biomimetics8010027

Morris Degen (left) won the prize for the best talk and Anamarija Nikoletić (right) the prize for the best poster at the Annual Event in 2024 at Lake Hallwil. SNI Director Martino Poggio (center) presented the prizes at the end of the two-day conference. (Image: K. Beyer-Hans, SNI, University of Basel)

"The SNI Annual Event is always a special highlight for me, as it offers a unique opportunity to gain insights into cutting-edge research outside my own field and to exchange ideas with researchers from a wide range of disciplines in a relaxed atmosphere. It was a great honor to receive the Best Talk Award for my presentation."

Morris Degen,
Doctoral student at the SNI PhD School and winner of the Best Talk Award at the Annual Event 2024

In 2024, seven SNI doctoral students successfully completed their dissertations, having carried out the corresponding experimental work at the Biozentrum, at the Departments of Chemistry and Physics of the University of Basel, at the FHNW School of Life Sciences, or at the Paul Scherrer Institute.

SNI doctoral students
Interdisciplinary networking

Successfully defending their doctoral dissertation is the crowning glory for all doctoral students. By this point, they have been fully integrated into research groups at various departments of the University of Basel (Biozentrum, Chemistry, Physics), the Paul Scherrer Institute PSI and the University of Applied Sciences Northwestern Switzerland (FHNW), as well as having overcome numerous hurdles during their dissertations and proving that they can deal with complex challenges independently. Over the past few years, they have gained a wealth of technical knowledge in their specialist field and successfully presented their results to relevant expert audiences through talks and publications.

At the same time, doctoral students at the SNI PhD School have not only built up a network within their field of research, but have also become part of the interdisciplinary SNI network. They have grappled with subjects well beyond their field, immersed themselves in other research topics, and discussed ideas with researchers from other disciplines. They have also learned to explain their research to a discerning non-specialist audience through numerous events organized by the SNI team, such as the “Nanoscience in the Snow” Winter School. In 2024, this event featured extended talks by the invited experts on nanomagnetism, surface chemistry, molecular biological methods, and the advantages of a doctorate on the startup scene. Likewise, broad-based training for doctoral students is supported by initiatives such as the startup workshop that was recently incorporated into the program or the course on communication or rhetoric. SNI events that are held on a yearly basis, such as the Annual Event and the NanoTec Apéro, also play a key role in ensuring that the young early career researchers are ideally equipped to continue their professional careers at the interfaces between different disciplines.

“I found the SNI PhD School to be an extremely valuable experience, involving a lively exchange of ideas and interdisciplinary opportunities not only for further development but also to look beyond one’s own horizons and for networking.”
Annika Huber,
former doctoral student at the SNI PhD School

SNI startup workshop
"From Lab to Startup"

Doctoral students from the SNI PhD School generally work on questions of basic research, but these topics are often only a short step away from innovative applications. In mid-October, seven SNI doctoral students gained insights into the world of founding a startup at the "From Lab to Startup" workshop. Under the guidance of experts, they developed business ideas, learned about the key steps in founding a company, and presented their ideas as part of a pitching competition.

The coordinator of the SNI PhD School, Dr. Andreas Baumgartner, worked with Anna-Elina Pekonen from the Innovation Office of the University of Basel to develop a new concept for the "From Lab to Startup" workshop, which is to be held on an annual basis going forward. In mid-October, Pekonen then hosted the first installment of this workshop together with Mauricio Campos, the owner of a consulting firm. As well as theoretical knowledge, Pekonen provided participants with practical experience. Two successful company founders shared their insights, and the students developed their own concepts for startups – generally based on their own research. Elizaveta Maksimova, from the team led by Professor Jonathan de Roo (Department of Chemistry), gave the best pitch and won the jury over with her clear presentation.

Through this program, the SNI seeks to encourage SNI doctoral students to explore alternative career pathways and examine practical applications of their research. The workshop was a complete success and will continue to support young researchers on their journeys in the future.

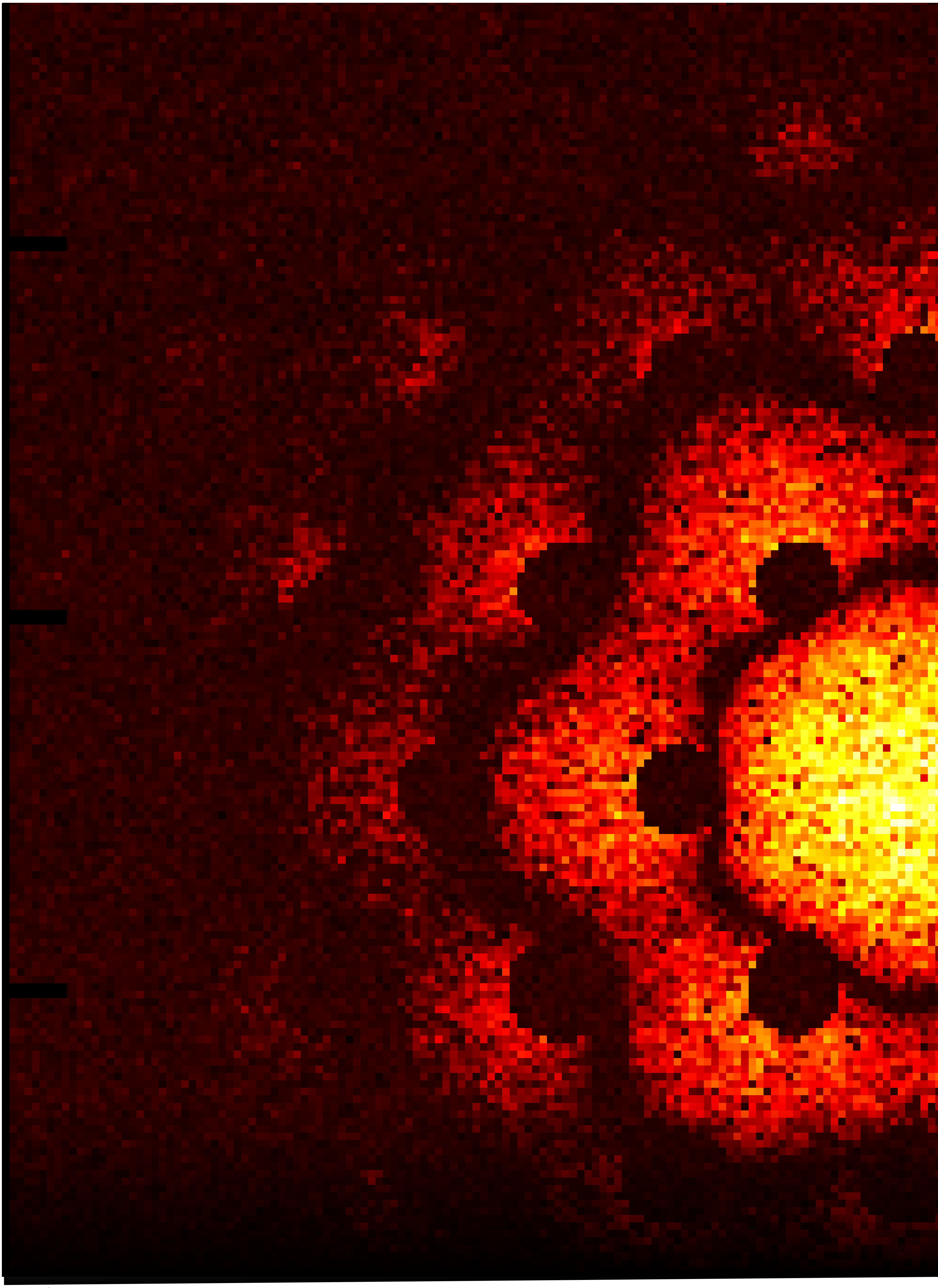
Report in SNI INSight: https://bit.ly/40OrE7r

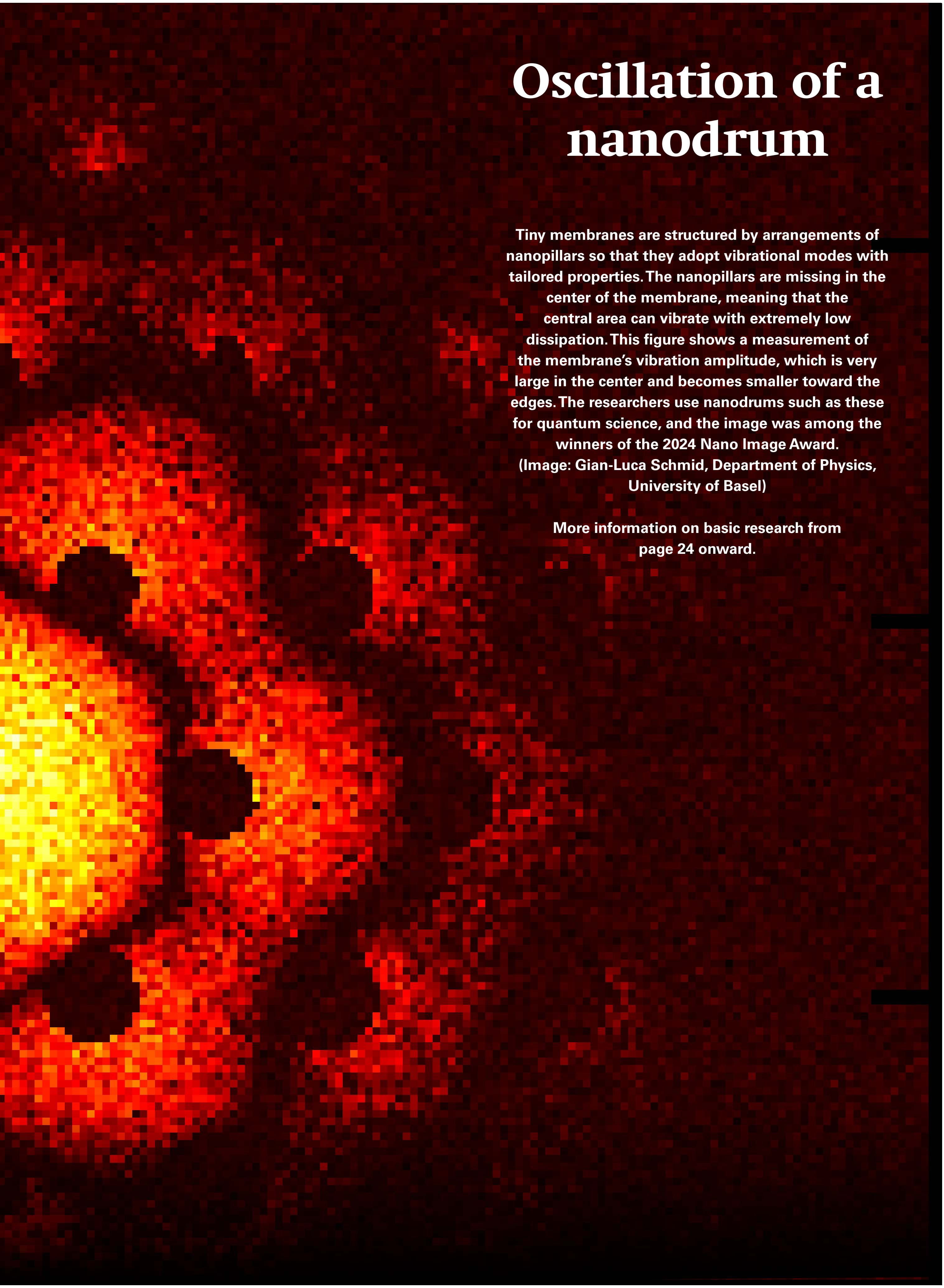
The concept of the "From Lab to Startup" workshop impressed both the participants and the course leaders. From now on, the workshop will be offered to a group of SNI doctoral students every year so that all members of the SNI PhD School experience these valuable insights into setting up a company once during their doctorate. (Image: A. Baumgartner, SNI, University of Basel)

At the workshop, Elizaveta Maksimova impressed the jury with her clear presentation and won the prize for the best pitch.

"I further developed the academic ideas from my dissertation project and felt very comfortable thinking about the next step to founding a startup. The SNI Rhetoric Workshop I attended last year really helped me deliver a convincing presentation."
Elizaveta Maksimova,
SNI doctoral student at the Department of Chemistry of the University of Basel and winner of the pitching competition

"It was great to see how the participants developed their projects in a very short time period of just 1.5 days, resulting in an impressive outcome."
Anna-Elina Pekonen,
Innovation Office, University of Basel





Oscillation of a nanodrum

Tiny membranes are structured by arrangements of nanopillars so that they adopt vibrational modes with tailored properties. The nanopillars are missing in the center of the membrane, meaning that the central area can vibrate with extremely low dissipation. This figure shows a measurement of the membrane's vibration amplitude, which is very large in the center and becomes smaller toward the edges. The researchers use nanodrums such as these for quantum science, and the image was among the winners of the 2024 Nano Image Award. (Image: Gian-Luca Schmid, Department of Physics, University of Basel)

More information on basic research from page 24 onward.

Research: Founded on basic science

A large part of research activities supported by the Swiss Nanoscience Institute focus on questions of basic science. After all, it is only by understanding how nanoscale systems work that we can develop applications based on this knowledge.

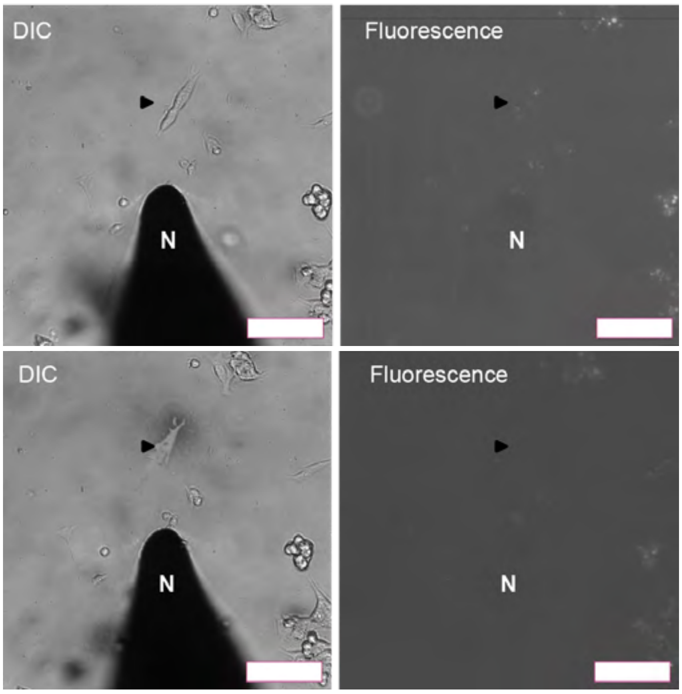
Researchers in the SNI network benefit from access to wide-ranging experts from the various partner institutions and departments. Accordingly, the research projects supported by the SNI are also highly diverse, ranging from questions about our understanding of fundamental quantum physical phenomena to approaches rooted in materials science and biomedical applications. At the same time, researchers in the SNI network focus primarily on making the nanoworld "visible" and on producing nanoscale structures and materials that can then be applied in fields including quantum, materials or environmental science as well as in the life sciences and medicine.

In 2024, scientists from the SNI network published 74 articles in renowned scientific journals. Here, we bring you a small selection of these publications in order to reflect the diversity of subject areas and findings obtained. Through this research work, SNI members help to gain a better understanding of processes and laws governing the world of tiny structures, thereby paving the way for potential applications.

Contents of individual cells

Researchers from the SNI network have described a new method for analyzing metabolic products and proteins from individual or small numbers of cells. The scientists use a short electroporation procedure to break open individual cells and aspirate the cell contents using a fine capillary under an optical microscope. They then analyze the samples using liquid chromatography-mass spectrometry (LC-MS) and other methods. This technique allows precise measurements of cell structures, metabolic products and proteins at single-cell level and opens up new possibilities for biomedical research.

Original publication: https://doi.org/10.1039/D4LC00269E

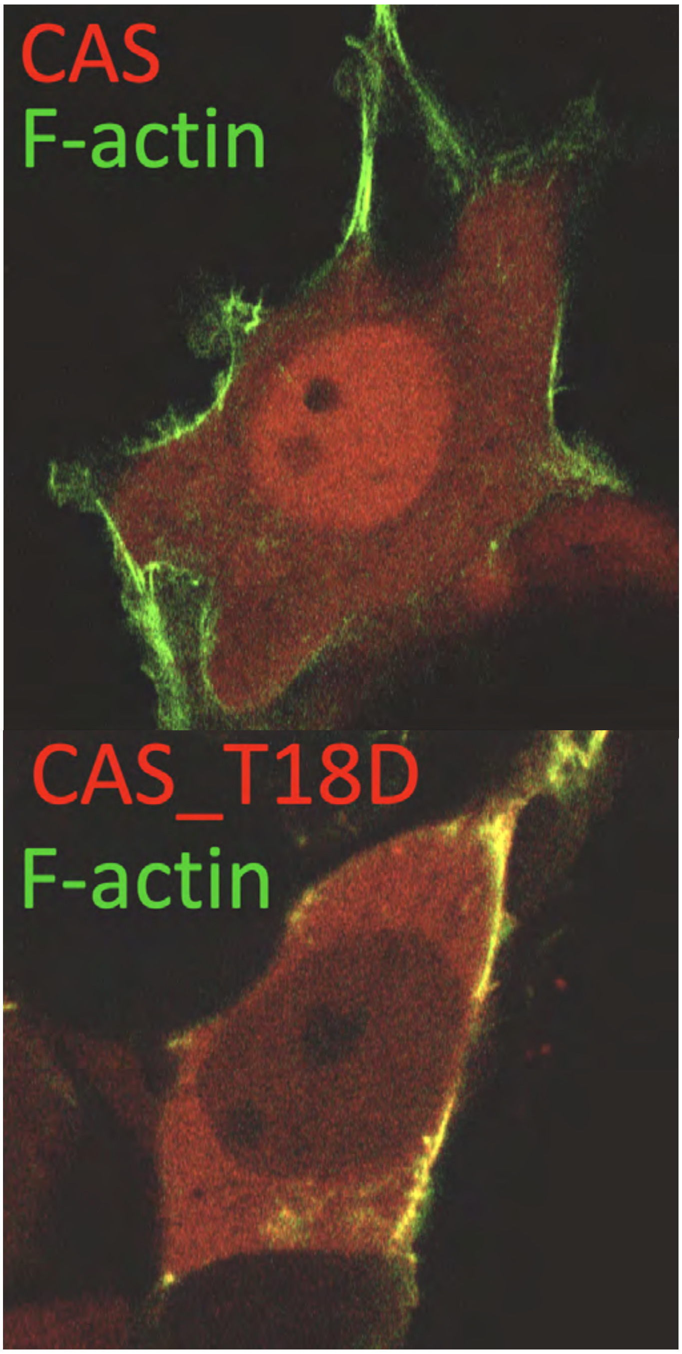


The top row shows a target cell (black arrow) before electroporation and aspiration of the cell contents. In the images in the bottom row, the cell contents have been aspirated. The fluorescent signal originates from labeled, pathogenic amyloids that were absorbed by the cell. The white bar corresponds to a length of 100 µm. (Image: A. Fränkl, L. Rima, Biozentrum, University of Basel)

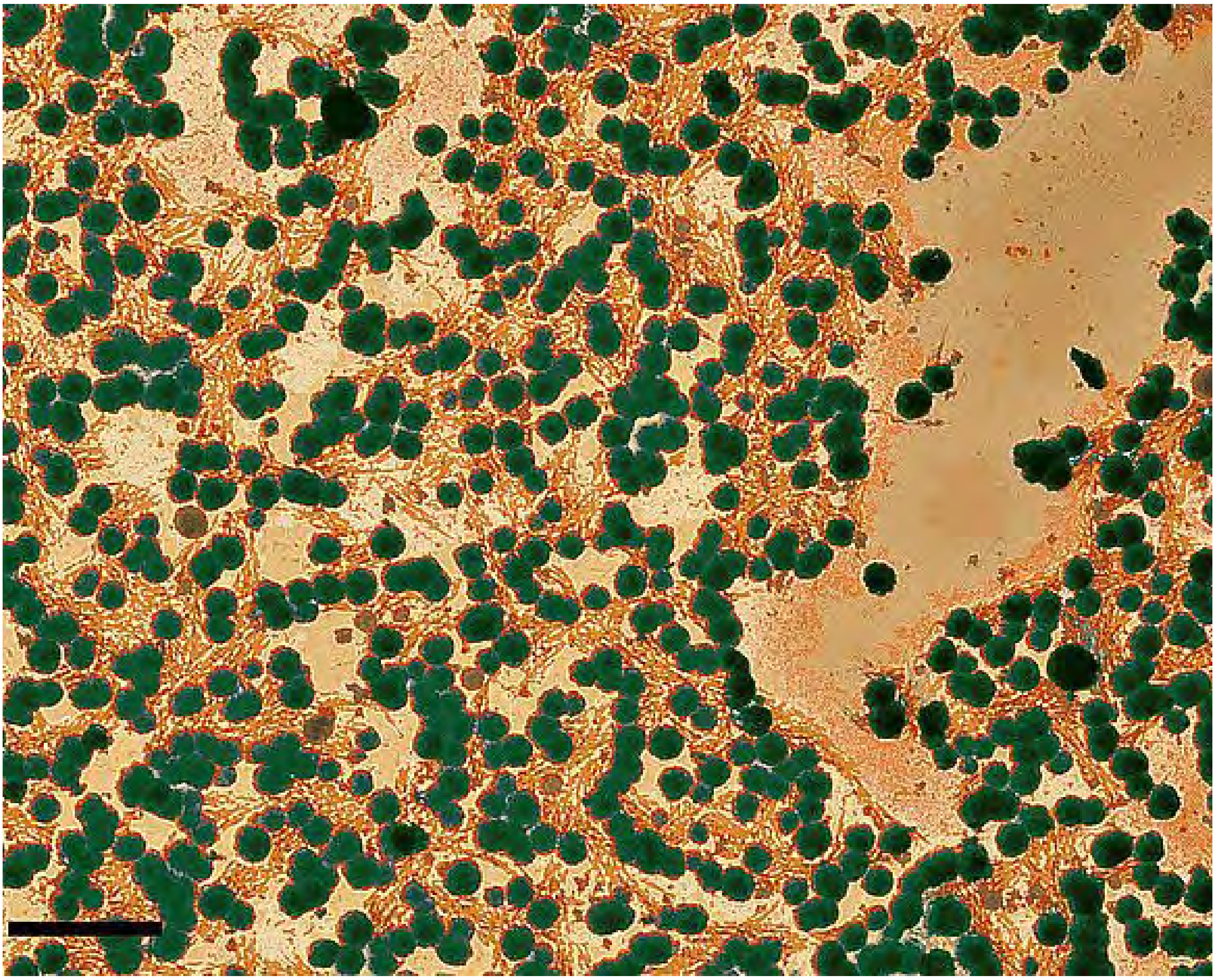
Fine-tuned interaction is key

A research team from the University of Basel has investigated specific proteins (exportins) that are involved in the transport of molecules from the cell nucleus to the cytoplasm. The study showed that certain areas of exportin-2 (also known as CAS) and other proteins ensure that CAS remains in the cell nucleus until it is needed. A mutation or an imbalance in this process can lead to pathological cell behavior, as is the case with cancer. These findings demonstrate the importance of the balanced interaction of proteins for transport into and out of the cell nucleus.

Original publication: https://rupress.org/jcb/article/223/2/e202306094/276511/Mechanism-of-exportin-retention-in-the-cell



Using a fluorescence microscope, the researchers observe the importance of finely tuned interaction between the exportins and RanGTP. A single mutation changes the fate of CAS in the cell nucleus, as illustrated by the difference between the wild-type (CAS) and a mutated form (CAS_T18D). (Image: L. Kapinos, Biozentrum, University of Basel)



Method for detecting nanoparticles in early life nutrition
In the Nano-Argovia program, researchers from the SNI network have developed a technique that can detect nanoparticles (that is, particles with a diameter of less than 100 nanometers) in early life nutrition products with a high sample throughput.

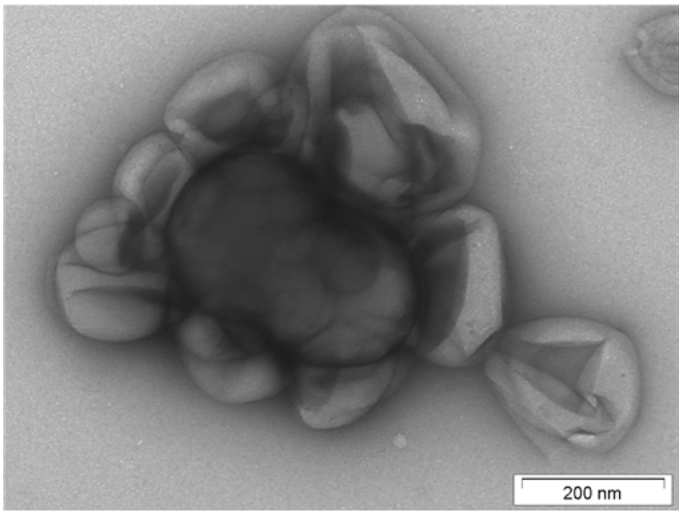
Original publication: https://doi.org/10.1021/acsomega.3c09459

Colorized transmission electron microscope (TEM) image of silicon dioxide nanoparticles (SiNPs, green) in a matrix (orange). Scale bar = 400 nm (Image: FHNW)

Nanocompartments for enzymatic reactions

Scientists from our network have developed novel nanoclusters inspired by the manner in which natural cells interact inside tissues. These smart clusters – which consist of catalytic nanocompartments (CNCs) loaded with enzymes precisely attached to Janus nanoparticles (JNPs) – are specifically assembled by programmed DNA hybridization. The unique asymmetry of the JNPs orients the arrangement of CNCs on specific lobes of Janus nanoparticles, while the clusters provide a confined space for different types of enzymatic reactions and induce their directionality. This new technology offers a powerful tool for designing smart materials with precise temporal and spatial control of the nanoscale reactions that are required in various fields, including in medicine and biotechnology.

Original publication: https://www.sciencedirect.com/science/article/pii/S1369702124001858?via%3Dihub

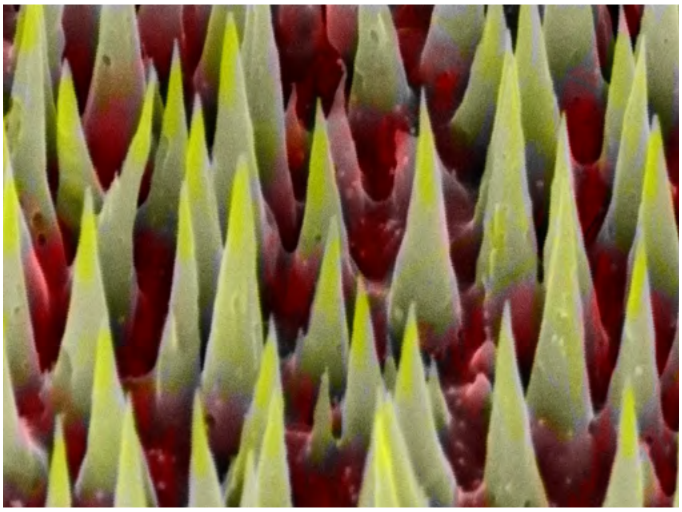


Electron microscope image of nanoclusters whose structure is modeled on natural cells in tissues. (Image: Department of Chemistry, University of Basel)

Nanostructures for better implants

Researchers from the SNI network have investigated how nanostructured titanium surfaces (Ti2 spikes) can improve dental implants. The interdisciplinary team investigated the viability of osteoblasts and fibroblasts and controlled how different bacterial strains colonized the modified surfaces.

Original publication: https://onlinelibrary.wiley.com/doi/10.1002/jbm.a.37768
Video: https://youtu.be/9yRkvINvL2w

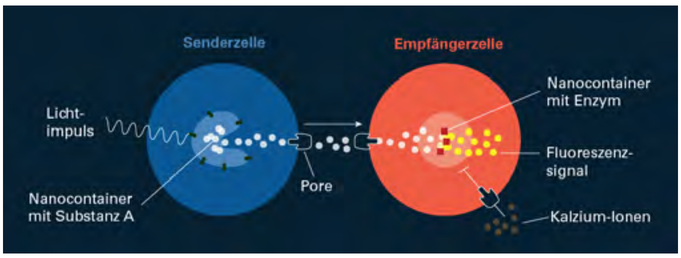


Nanostructured titanium surfaces can influence the growth of bacteria and impact the viability of osteoblasts and fibroblasts. (Image: Department of Physics, University of Basel)

Synthetic cells emulate natural cellular communication

A team of researchers from the University of Basel has succeeded in synthesizing simple, environmentally sensitive cells complete with artificial organelles. For the first time, the researchers were also able to emulate natural cell-cell communication using these protocells – based on the model of photoreceptors in the eye. This opens up new possibilities for basic research and applications in medicine.

Original publication: https://doi.org/10.1002/adma.202413981

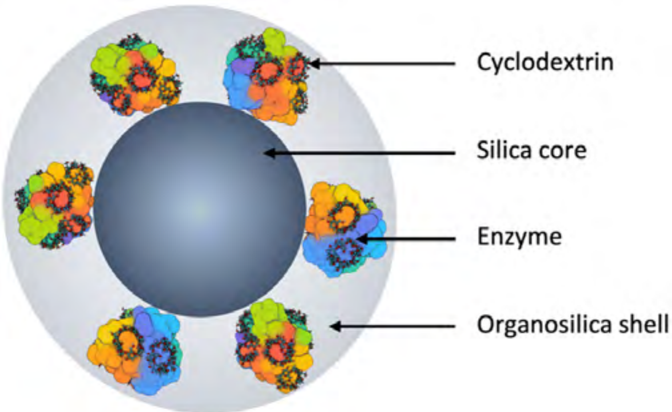


Schematic representation of synthetic cell communication. (Illustration: Olivia Fischer, University of Basel)

Protecting enzymes

Researchers from the SNI network have investigated methods for stabilizing enzymes by tailoring their nanoenvironment and without impairing their structure or function. To this end, they used ring-shaped sugar molecules (cyclodextrins) that stabilized the three-dimensional structure of the proteins due to supramolecular interactions with their surface. The protective effect can be further enhanced if the cyclodextrins are integrated into an organosilica layer. Enzymes immobilized in this way showed improved heat stability and recovery after damage by various stress factors.

Original publication: https://doi.org/10.1002/cbic.202400840



Enzymes can be immobilized and protected with the help of the nanoenvironment. (Image: FHNW)

Width of artificial pores is crucial

Researchers within the SNI network have shown that the width of nuclear pore complexes is critical in transport into and out of the cell nucleus and that nuclear transport receptors play an active role in transport regulation.

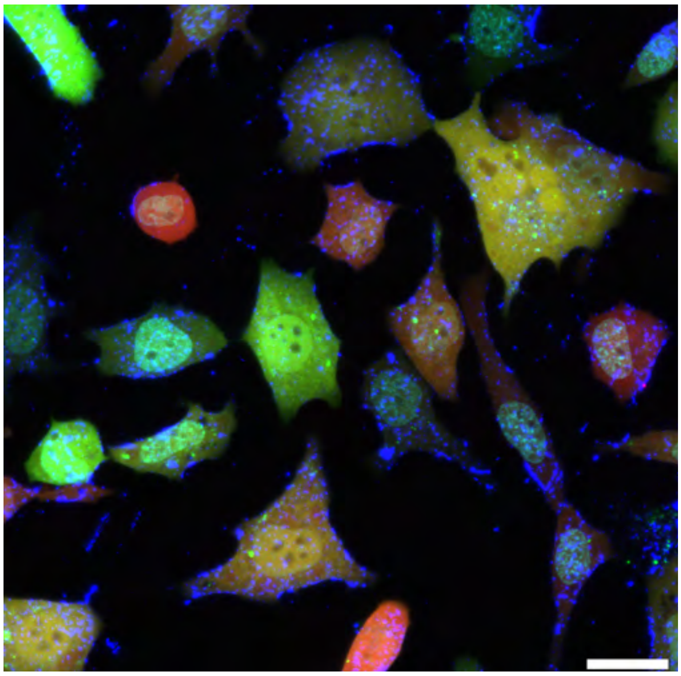
Nucleoporins in nuclear pore complexes form a selective barrier that suppresses the diffusion of most large molecules while enabling the rapid transport of molecules bound to nuclear transport receptors. Now, the researchers have constructed artificial pores from DNA with different diameters and nucleoporin arrangements. Using virus particles, the researchers found that certain nucleoporins formed an impermeable barrier for the virus particles in narrow pores (60 nm), while they were less effective in larger pores (79 nm).

Original publication: https://www.science.org/doi/10.1126/sciadv.adq8773

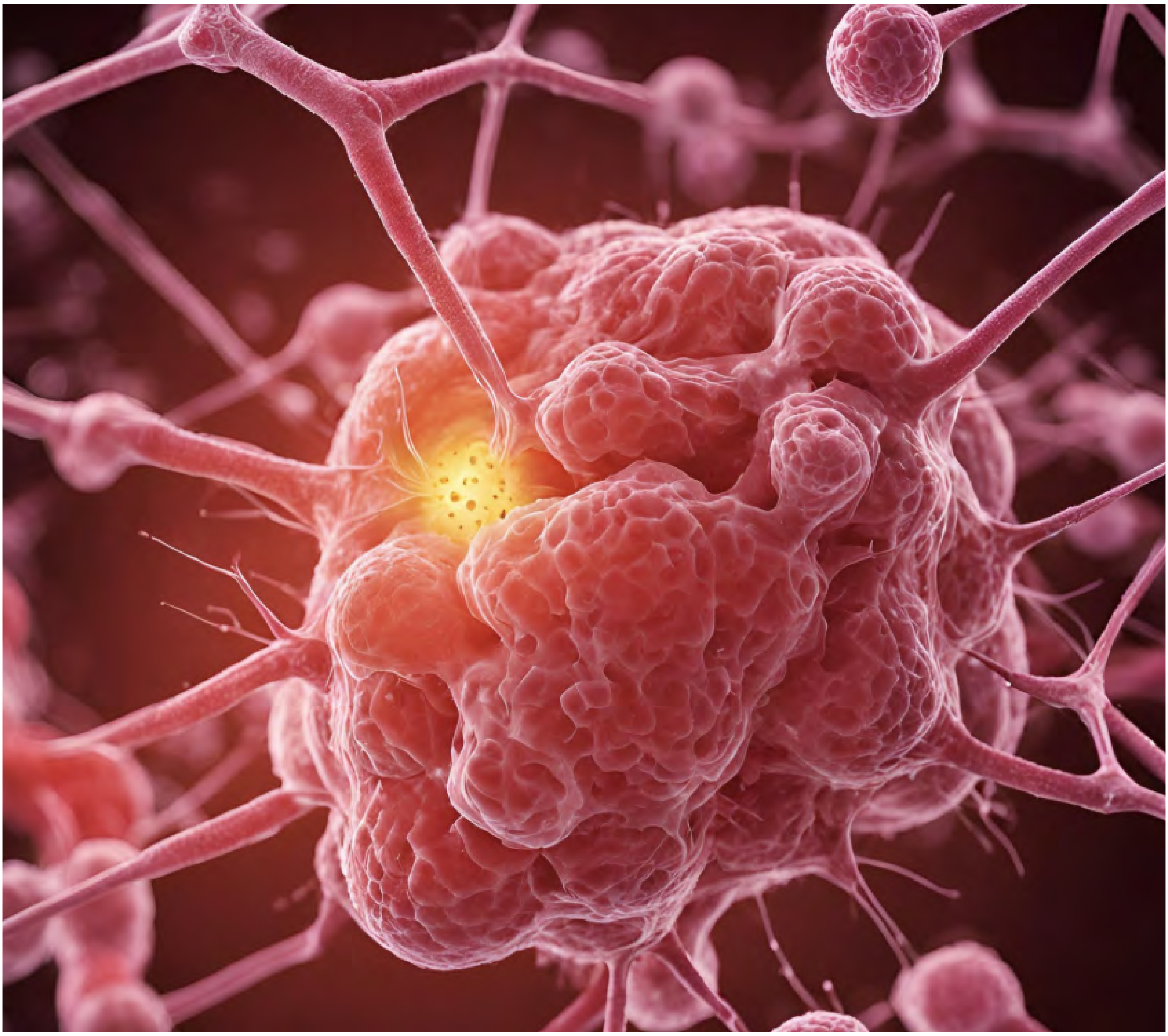
Hybrid transport system for genetic material

Lipid nanoparticles are an important means of transport for genetic material (nucleic acids) and came to attention partly due to COVID-19 vaccines. Their efficiency is limited, however, as only a small proportion of the transported nucleic acids enters the cells. To improve the level of uptake, researchers from the SNI network combined lipid nanoparticles with vesicles derived from natural cells. The resulting hybrids showed a significantly increased rate of gene expression *in vitro* and *in vivo*. The inclusion of cell-derived vesicles could potentially streamline the development process and significantly improve the efficacy and potency of gene delivery systems without the need for extensive screening.

Original publication: https://doi.org/10.1002/adhm.202401888



Researchers use fluorescence microscopy to check the expression of genes that were introduced into cells using the hybrid transport system. (Image: C. Alter, Department of Pharmaceutical Sciences, University of Basel)



The tumor microenvironment is often associated with a very low pH value. Researchers from the SNI network are investigating how nanoparticles can be used to neutralize intracellular acidity of tumor and immune-suppressing cells. Initial studies indicate that reducing the acidity can have a positive effect on the body's immune response to the tumor. (Image: FHNW, generated with Canva)

Nanoparticles for more effective immunotherapy

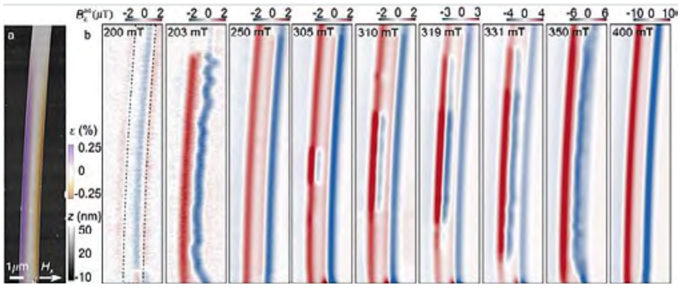
Researchers from the SNI network have explored an innovative approach with a view to improving the effectiveness of existing cancer treatments such as immunotherapies. To this end, they developed nanoparticles carrying a drug known as esomeprazole (commonly used to treat gastric acidity) in order to target and reduce tumor acidity. When tested on skin cancer cells, these nanoparticles not only reduced the acidic environment of tumor cells, but also altered their behavior. This included a reduction in factors that help tumors evade the immune system. Moreover, the treatment modified immunosuppressive cells from patients in a way that boosted their ability to support the body's natural immune response against cancer.

Original publication: https://doi.org/10.1016/j.isci.2024.111559

Reversal of magnetism through stretching

Ribbons of the two-dimensional semiconductor chromium sulfide bromide (CrSBr) change their magnetization when they are stretched. Researchers from the SNI network have published details of how they selectively stretch thin chromium sulfide bromide ribbons consisting of a few atomic layers and observe them using a cantilever probe with an integrated superconducting quantum interference device (SQUID). The researchers were able to prove that the layered, two-dimensional CrSBr loses its antiferromagnetic properties due to stretching and becomes a ferromagnet. They reproduced this change in magnetization, as well as the formation of domains, using a micromagnetic model.

Original publication: https://doi.org/10.1021/acs.nanolett.4c03919

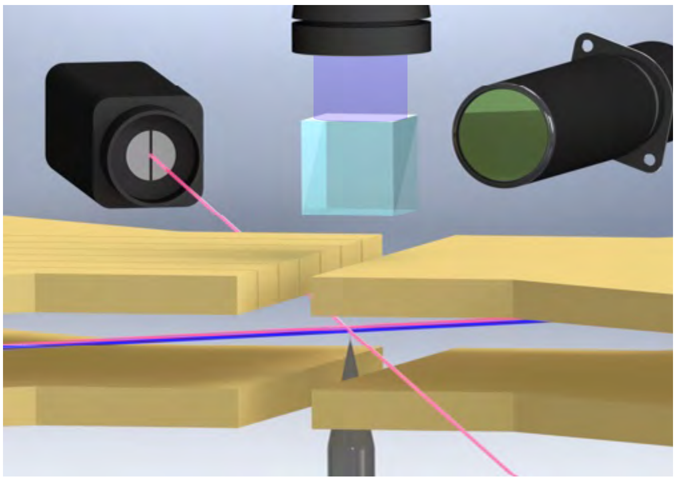


Magnetic field dependence of a strained chromium sulfur bromide ribbon. (Department of Physics, University of Basel)

Coupling between a nanowire and ions

As part of a doctoral thesis at the SNI PhD School, researchers have combined an ultra-thin metal wire (nanowire) with coolable ions in a special trap. They were able to set the ions in motion in a targeted manner by mechanically vibrating the nanowire – both resonantly (in harmony with the natural movement of the ions) and non-resonantly. The results show that it is possible to achieve mechanical coupling between ions and a nano-oscillator. In the future, this could open up new avenues for mechanically controlling the motion of trapped ions or for the development of hybrid quantum systems.

Original publication: https://doi.org/10.1103/PhysRevLett.133.223201

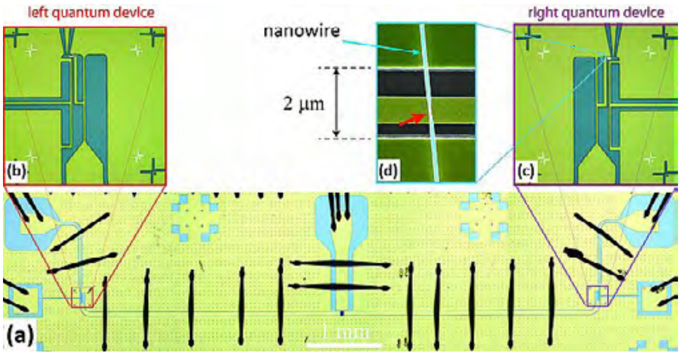


In a special trap (represented by the yellow structures), ions can be set in motion by mechanical vibrations of a nanowire (at the gray tip). (Image: Department of Chemistry, University of Basel)

Strong coupling between Andreev qubits mediated by a microwave resonator

Physicists from the University of Basel have succeeded in coupling two Andreev qubits coherently over a macroscopic distance for the first time. They achieved this using microwave photons generated in a narrow superconducting resonator. The results of the experiments and accompanying calculations were recently published, laying the foundation for the use of coupled Andreev qubits in quantum communication and quantum computing.

Original publication: https://www.nature.com/articles/s41567-024-02630-w

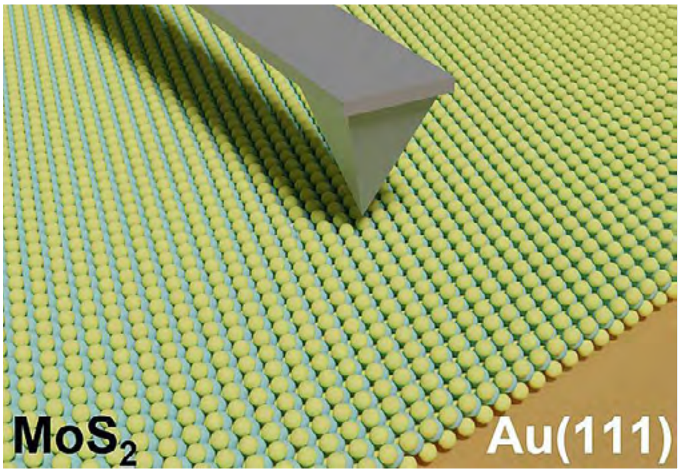


Andreev qubit coupler: The long microwave resonator (a) couples two Andreev qubits (left (b), right (c)). The port in the center of image (a) is the readout port. The magnification of a single nanowire (d) gives an idea of the tiny size of a single qubit, and the nanowire is coated with a superconductor (cyan). The actual Andreev bound state, which forms the qubit states, is located in the central white section marked by the red arrow. There is also a similar nanowire on the left quantum device. (Image: C. Schönenberger, Department of Physics, University of Basel)

Friction depends on speed

Researchers from the University of Basel have demonstrated that on the nanometer scale, frictional forces depend on speed. The researchers moved the tip of an atomic force microscope (AFM) over a monolayer of molybdenum disulfide on a gold surface and found that the friction between the AFM tip and the surface decreases over a broad speed range from 10 to 100 nanometers per second. These results deviate from the classical Coulomb's law of friction, which describes the independence of friction from velocity.

Original publication: https://doi.org/10.1103/PhysRevLett.133.136201

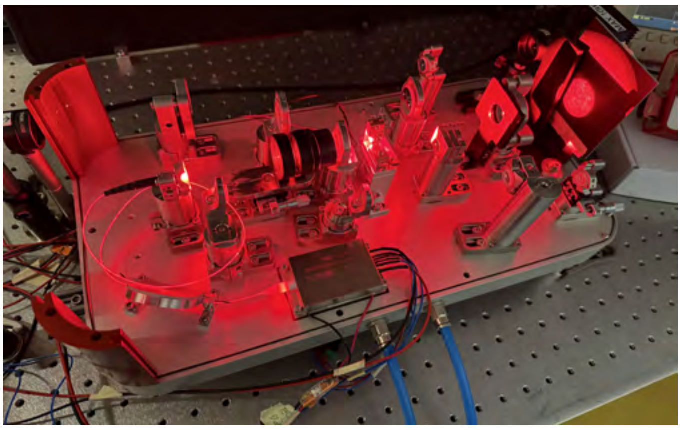


Researchers use an AFM to investigate friction on the nanometer scale over a monolayer of molybdenum disulfide on a gold surface. (Image: Department of Physics, University of Basel)

Novel femtosecond laser

Researchers from the SNI network have developed ultrashort alexandrite lasers that are pumped with recently developed red laser diodes at 638 nm. These lasers are suitable for various high-tech applications. As well as providing high peak power, the combination of direct diode pumps and the extremely short light pulses (44 and 95 femtoseconds) makes the lasers particularly efficient and versatile for modern applications in science and technology.

Original publication: https://doi.org/10.1364/OE.542834

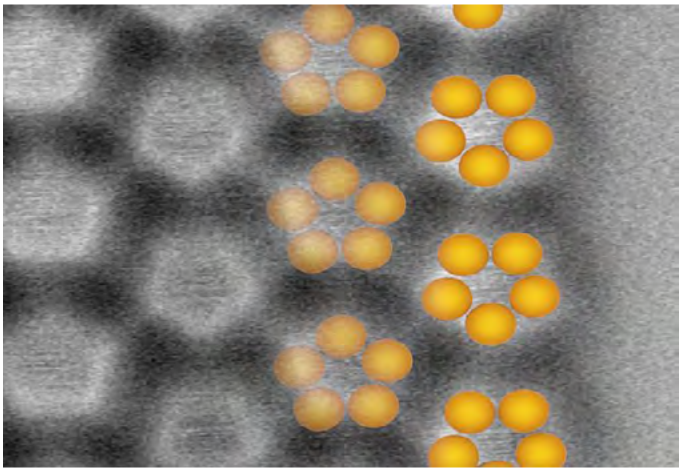


The researchers used the newly developed femtosecond laser to develop optical tweezers as part of the Nano-Argovia project NanoFemtoTweezers.

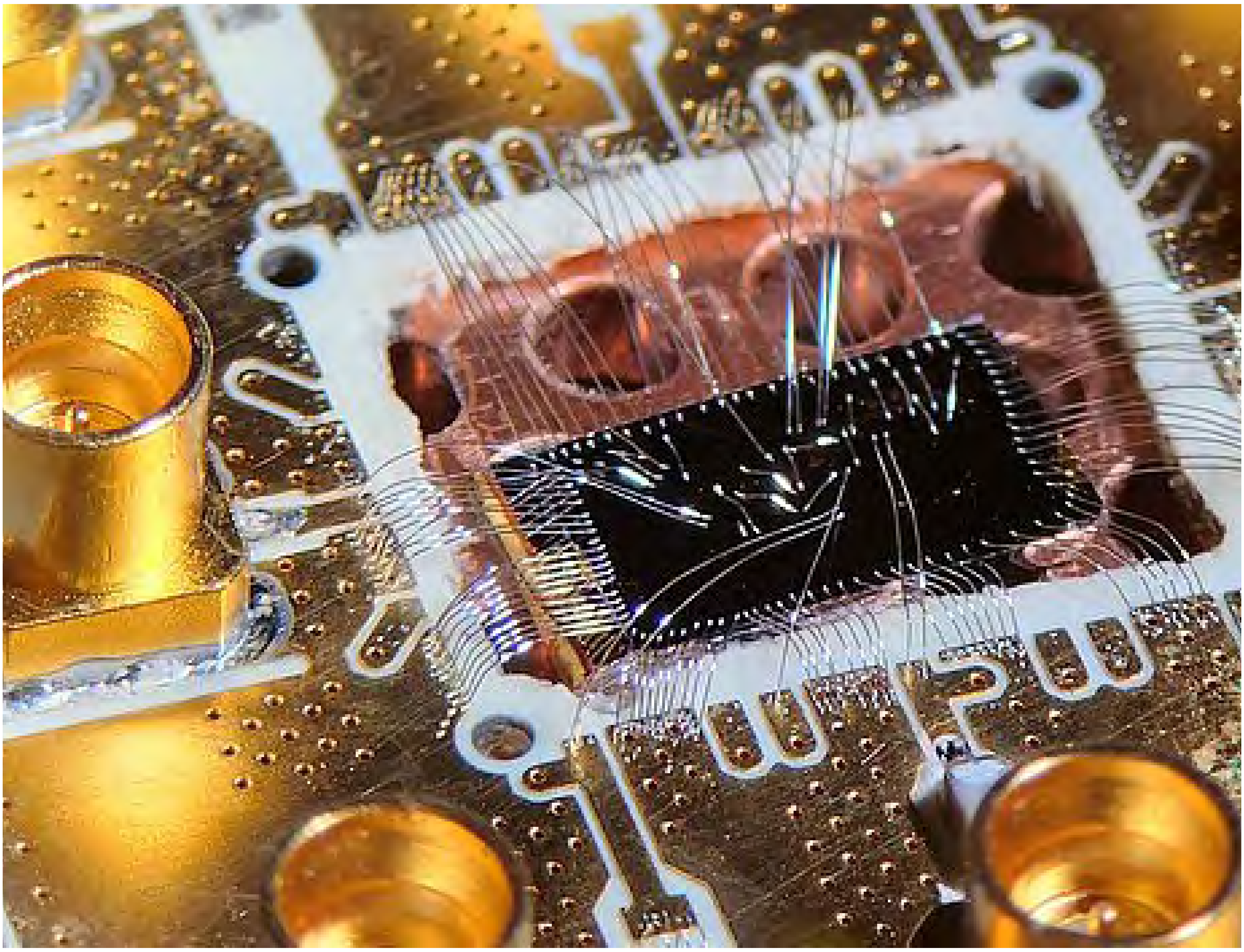
2D layer of phosphorus pentamers shows semiconductor properties on silver surface

Researchers at the University of Basel have synthesized five-membered rings of phosphorus atoms (phosphorus pentamers (cyclo-P5)) on a silver surface and investigated their electronic properties for the first time using combined atomic force and scanning tunneling spectroscopy. The researchers found that the atomic phosphorus pentamer layer retains its semiconductor properties and that a special electronic interface forms at the boundary with the silver surface (p-type semiconductor-metal Schottky junction). The phosphorus pentamers on the silver surface therefore fulfill a basic requirement for applications in field-effect transistors, diodes or solar cells.

Original publication: https://www.nature.com/articles/s41467-024-50862-4
SNI post: https://bit.ly/4jAWwRt



When two-dimensional layers containing rings of five phosphorus atoms (phosphorus pentamers) are formed by self-assembly on a silver surface, the phosphorus layer retains its semiconductor properties, and a special interface (a p-type semiconductor-metal Schottky junction) forms at the boundary with the silver surface. (Image: R. Pawlak, Department of Physics, University of Basel)



Strong spin-photon coupling

Researchers from the SNI network have achieved strong coupling between an electron spin and a single photon. Normally, there is only very weak coupling between a single photon and an electron spin. To achieve strong coupling, the researchers therefore used a special indium arsenide crystal structure, which couples the electron spin naturally to its motional degree of freedom, thereby making it open to interaction with a microwave photon.

Original publication: https://www.nature.com/articles/s41467-024-45235-w

SNI post: https://bit.ly/40Q2fdG

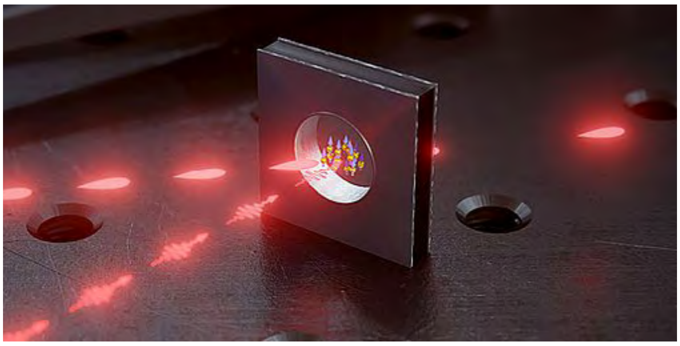
Using a complex experimental setup, researchers from the SNI network achieved strong coupling between an electron spin and a photon. (Image: A. Pally, Department of Physics, University of Basel)

Mass-producible miniature quantum memory

Researchers at the University of Basel have built a quantum memory element based on atoms in a tiny glass cell. In the future, quantum memories of this kind could be mass-produced on a wafer.

Original publication: https://doi.org/10.1103/PhysRevLett.131.260801

News report from the University of Basel: https://bit.ly/3CZwpmQ



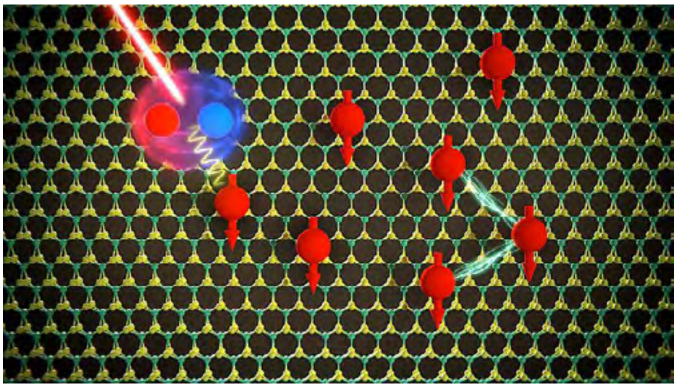
Light pulses can be stored in and retrieved from the glass cell, which is filled with rubidium atoms and is only a few millimeters in size. (Image: University of Basel, Department of Physics/Scixel)

New method for determining the exchange energy of 2D materials

Researchers from the University of Basel have looked at how the ferromagnetic properties of electrons in the two-dimensional semiconductor molybdenum disulfide can be better understood. They revealed a surprisingly simple way of measuring the energy needed to flip an electron spin.

Original publication: https://doi.org/10.1103/PhysRevLett.133.026501

SNI post: https://bit.ly/3EJ4Kad



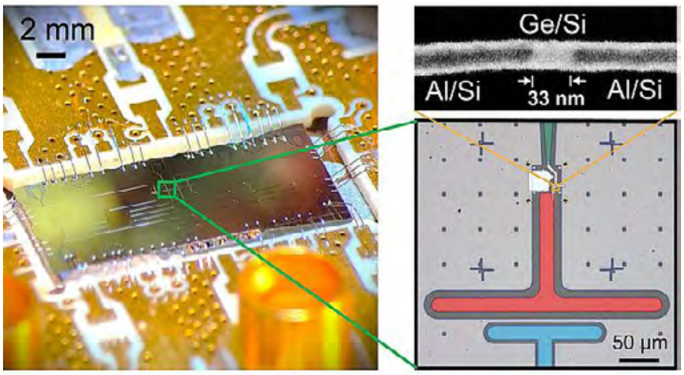
The two-dimensional semiconductor material molybdenum disulfide is filled with electrons (red spheres). Electron-electron interactions cause the spins of all electrons (red arrows) to align in the same direction. The exchange energy needed to flip a single electron spin in the ferromagnetic state can be determined from the separation between two specific spectral lines. (Image: N. Leisgang, Harvard University, formerly Department of Physics, University of Basel/Scixel)

Voltage-tuned superconducting qubits

Researchers from the SNI network have developed a new qubit platform that may be suitable for various applications. In contrast to conventional superconducting qubits made of metals, the team combined a technologically relevant semiconductor with superconducting elements to create a "gatemon" qubit with promising properties.

Original publication: https://doi.org/10.1021/acs.nanolett.4c00770

SNI post: https://bit.ly/4k4jocq



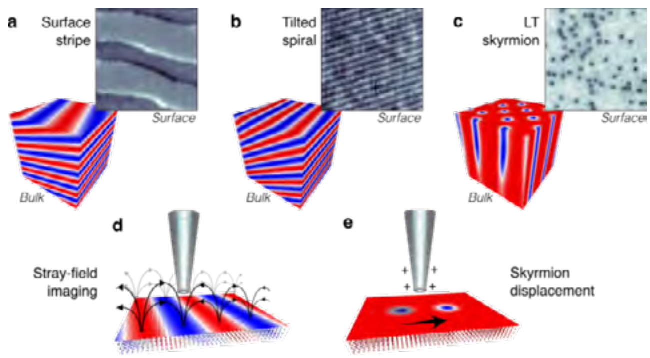
The researchers from Basel fabricated a high-quality Josephson junction on a germanium/silicon nanowire between two superconductors (black and white image, top right), thereby producing the central part of a "gatemon" qubit. (Image: H. Zheng, Department of Physics, University of Basel).

Control of skyrmions possible

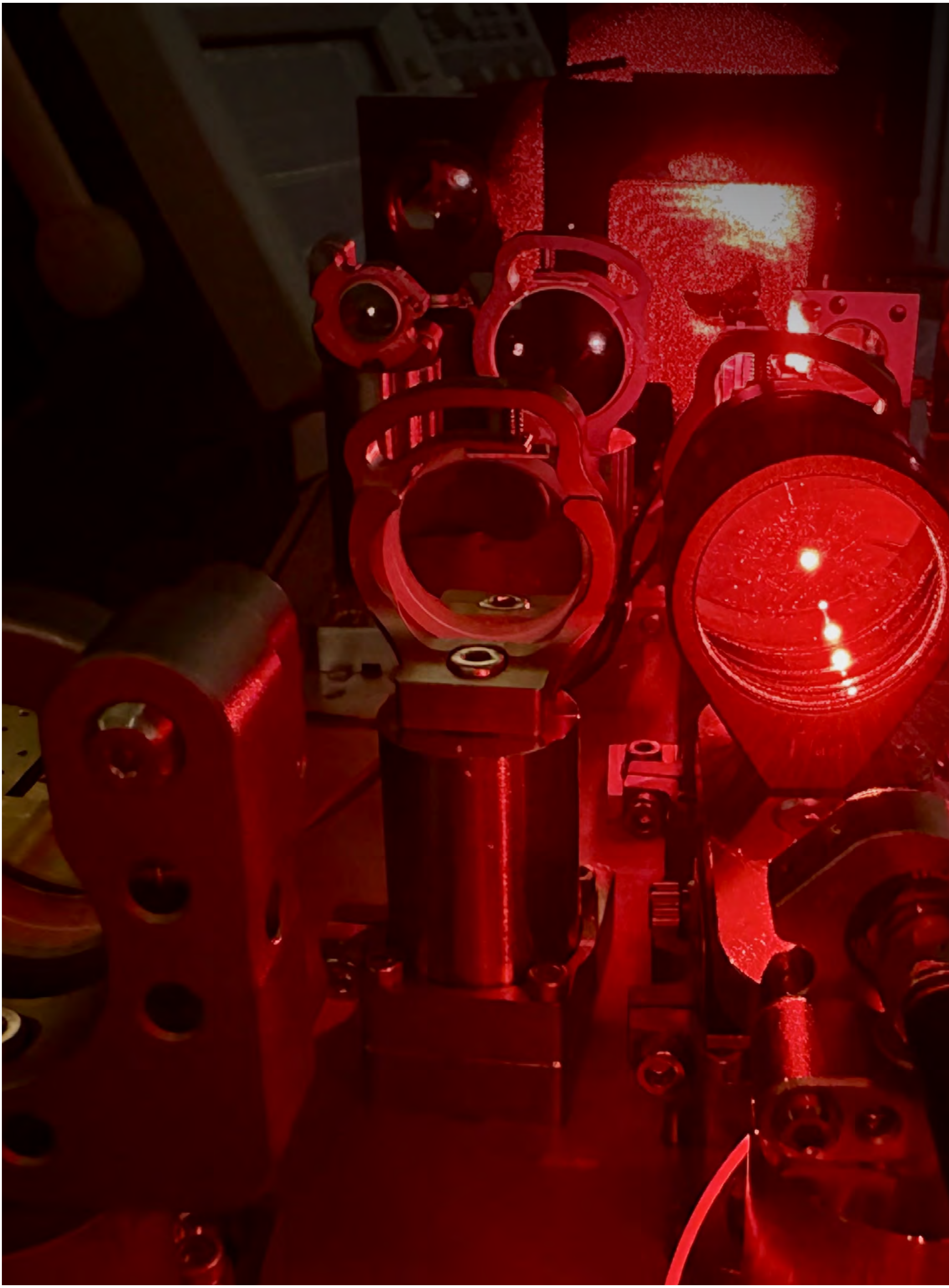
Using scanning SQUID microscopy at very low temperatures, researchers from the SNI network have visualized the microscopic structure of magnetic phases and their transitions on the surface of the insulator Cu_2OSeO_3. The researchers observed that under certain conditions, the surface is populated by clusters of disordered magnetic vortex structures (skyrmions), and that individual skyrmions could be controlled locally.

Original publication: https://www.nature.com/articles/s43246-024-00647-5

SNI post: https://bit.ly/41oONyY



The microscopic structure of the magnetic phases and transitions of the insulator Cu_2OSeO_3. (Image: Department of Physics, University of Basel)



Cooperation as the key to innovation

The SNI’s Nano-Argovia program is a guarantee for effective knowledge and technology transfer between research institutions and industrial companies from Northwestern Switzerland. Each year, the SNI supports around ten applied research projects in which interdisciplinary teams work to solve a wide range of challenges.
More on this from page 36

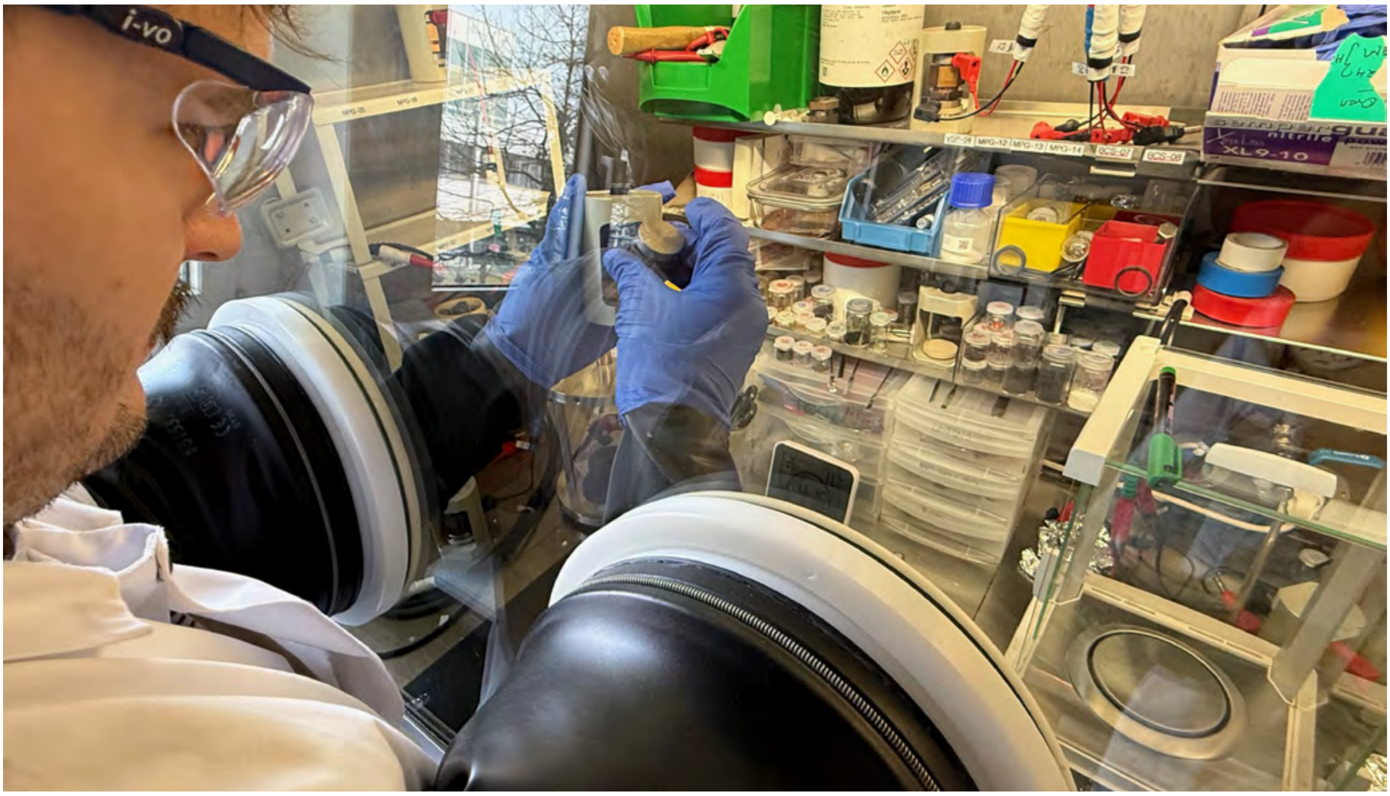
Lasers have already played a role in several Nano-Argovia projects. In the NanoFemto Tweezers project, novel lasers are used in combination with nano-optical elements as optical tweezers. The researchers want to use them to precisely assemble different cell types into a complex organ system on a microscopic surface.
More on page 43

Nano-Argovia program: Productive collaboration with companies from Northwestern Switzerland

Ever since the SNI was founded, a priority has been the promotion of knowledge and technology transfer with a view to driving progress and innovation at companies. The SNI supports this transfer through its Nano-Argovia program, which has existed since the institute's establishment. As part of this successful initiative, the SNI has so far funded around 100 projects in collaboration with almost 70 companies from Northwestern Switzerland, helping them take the first steps toward numerous nanotechnological applications.

In 2024, the Nano-Argovia program funded a total of 10 projects. Five of these began in 2024, while five project teams had begun their research back in 2023. In six of the projects, the partner companies hailed from the Canton of Aargau, while the partners in the other four hailed from one of the Basel half-cantons. In terms of the academic partners, the participants were primarily staff of the Paul Scherrer Institute PSI and the University of Applied Sciences Northwestern Switzerland (FHNW) in Muttenz and Windisch – although researchers from the University of Basel and CSEM Allschwil also acted as project partners, using their expertise to drive advances in these interdisciplinary topics of research.

Nano-Argovia program: www.nano-argovia.swiss



In a protected atmosphere, doctoral student Robin Wullich assembles prototypes of the "reservoir-free" lithium metal solid-state battery cells in order to subsequently investigate their electrochemical properties.

> **"The project potentially allows us to enter the value chain of Gen 3 and Gen 4 lithium-metal cell technology with a strong unique selling proposition."**
> Dr. Phani Kumar Yalamanchili, Oerlikon Metco AG

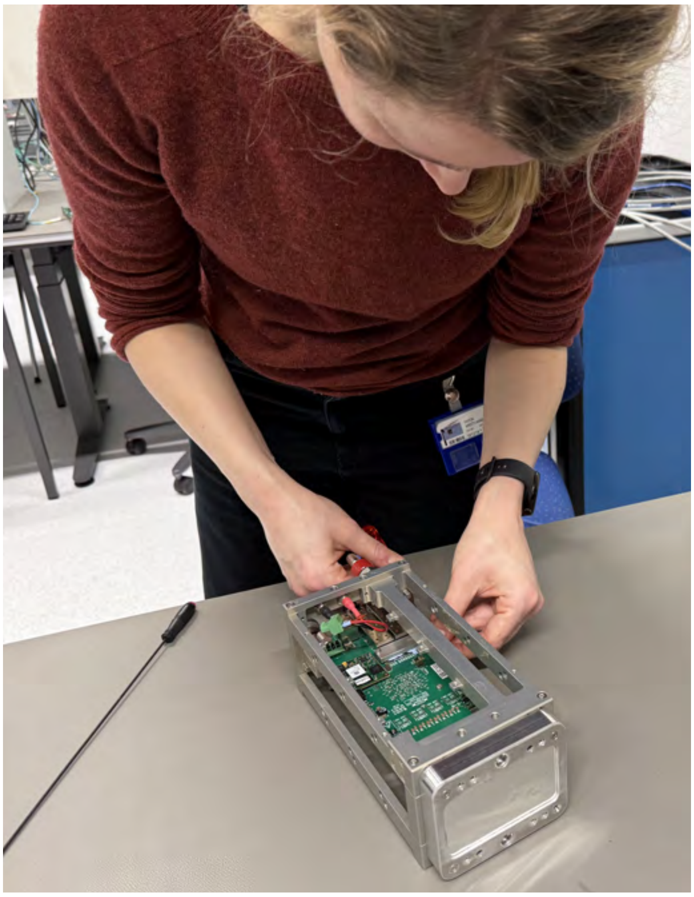
Better and safer lithium batteries

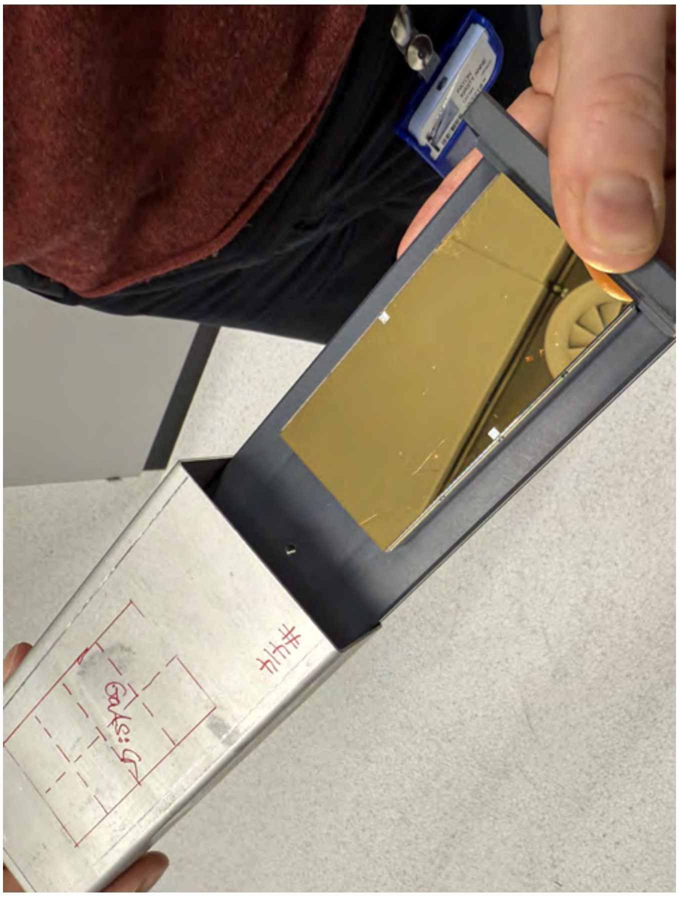
In the Nano-Argovia project BatCoat, researchers began developing the next generation of zero-excess all-solid-state lithium-metal battery cells in early 2024. These solid-state Li-metal batteries represent a promising alternative to conventional lithium-ion battery cells. They have a higher energy density and are safer than the lithium-ion batteries used today. Accordingly, they could make a decisive contribution to effective, safe and sustainable electromobility. At present, however, there are still some technical challenges, which are being investigated by the interdisciplinary team in the Nano-Argovia project BatCoat.

The negatively charged electrode (anode) of the zero-excess all-solid-state lithium-metal battery cells being investigated consists of a three-dimensional copper current collector, on which the researchers deposit functional layers. These layers help to ensure that the lithium emitted by the cathode is deposited reversibly and evenly. In the first year of the project, the interdisciplinary team successfully tested how these nanoscale functional layers can be deposited on the anode and what properties they have. The researchers have already achieved very promising cycling performance of 200 charge and discharge cycles with a capacity retention of 80% at a current density of 0.5 mA/cm^2. In the second year, the objective is to double or triple that performance in order to make it attractive for the battery industry.

Collaboration between: Paul Scherrer Institute PSI // FHNW School of Engineering and Environment // Oerlikon Metco AG (Wohlen, AG)

Project description: https://bit.ly/3CM6sqR





Detector for better electron microscope images

In the Nano-Argovia project HiZfEM, researchers have begun developing a new hybrid pixel detector with improved image quality for transmission electron microscopy. Like conventional models, the new electron detector is made up of two separate layers, in which the sensor part is separated from the readout chip. At present, comparatively thick silicon sensors are used as the detector layer in order to protect the sophisticated readout electronics from the incident high-energy electrons – but these thick silicon sensors limit the imaging quality due to multiple scattering in the sensor.

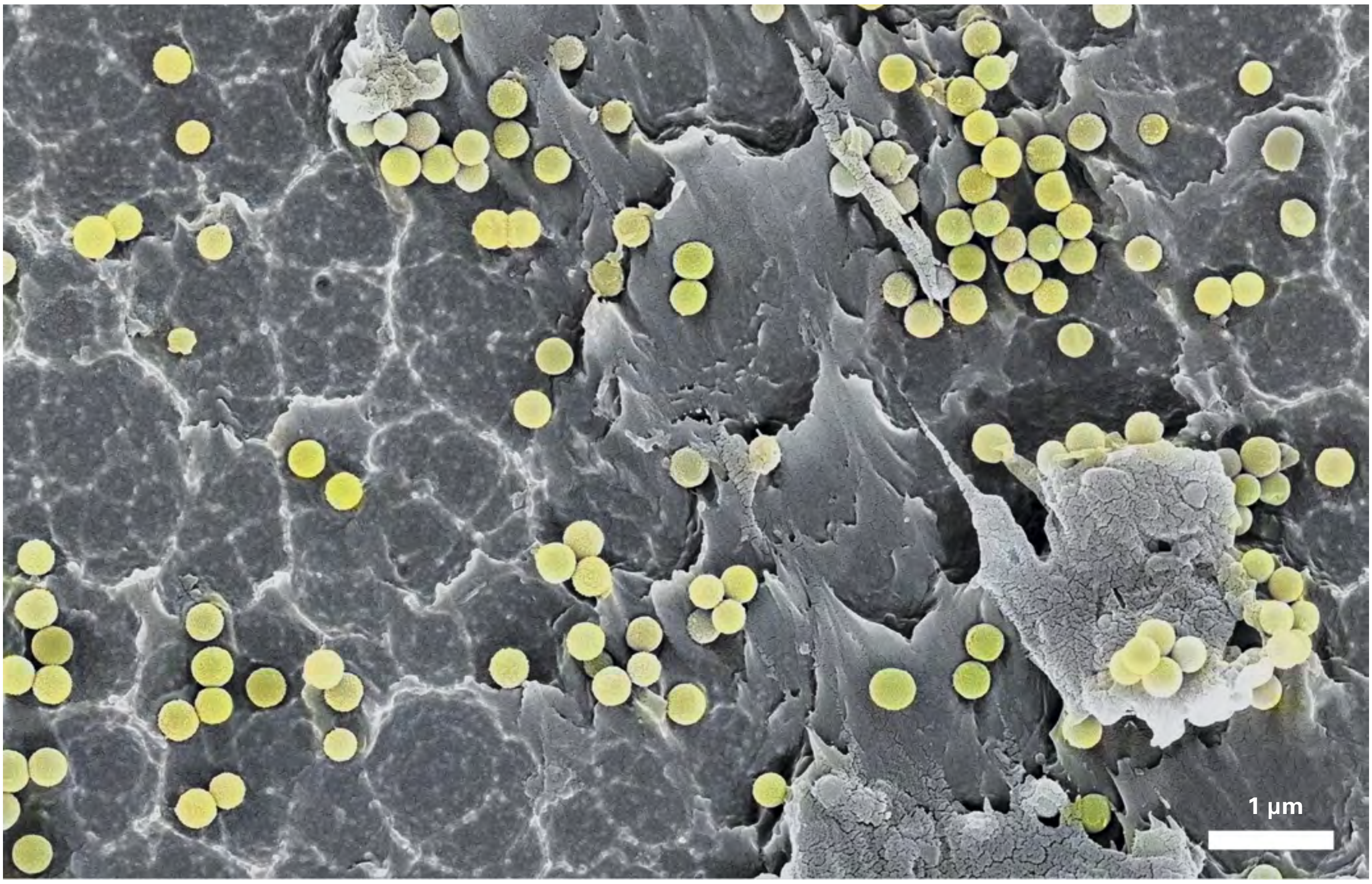
In the Nano-Argovia project HiZfEM, however, the interdisciplinary team has now used chromium-doped gallium arsenide (GaAs) as the detector material. In the project's first year, the researchers produced several components and characterized them using photons. They have pushed forward with data analysis and have already shown that it is possible to achieve a significant improvement in image resolution. Initial tests on an electron microscope have delivered some very promising results.

Collaboration between: Paul Scherrer Institute PSI // Biozentrum, University of Basel // DECTRIS AG (Baden, AG)

Project description: https://bit.ly/4hRwNCK

The team in the Nano-Argovia project HiZfEM produced the electronic components required to put the new hybrid pixel detector into operation. The researchers expect the new detector material (chromium-doped gallium arsenide) to generate electron microscopic images with significantly better resolution.

"We're thrilled to collaborate on the HiZfEM project, where our advanced GaAs material will play a crucial role in pushing the boundaries of electron microscopy. This collaboration with esteemed institutions like the Paul Scherrer Institute and the University of Basel underscores our commitment to pioneering scientific advancement and solidifies our position at the forefront of hybrid pixel detector technology."
Dr. Sonia Fernandez,
DECTRIS AG



Scanning electron microscope image of a PET film that is degraded by enzyme-based nanocatalysts developed at the FHNW as part of the NANOdePET project. (Image: FHNW)

"This collaboration with FHNW, financially supported by the SNI, offers INOFEA an opportunity to expand its portfolio of nano-engineered enzymes and to address environmental concerns by providing a sustainable solution to plastic waste. INOFEA expects to gain a competitive edge and meet market demand for environmentally friendly products."
Dr. Rita Correro,
INOFEA AG

Enzymes to combat plastic waste

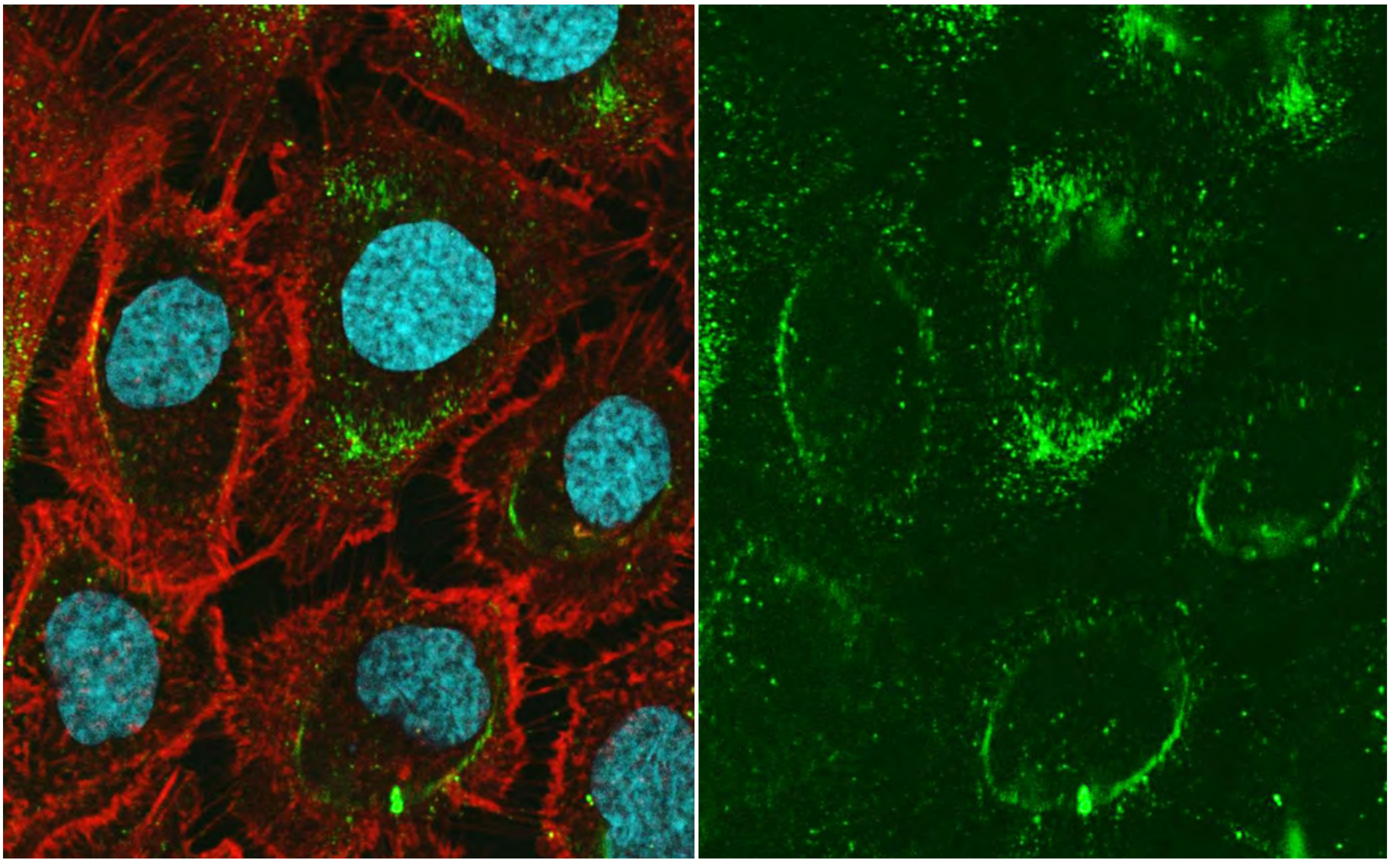
In the Nano-Argovia project NANOdePET, researchers are working on an improved degradation method for polyethylene terephthalate (PET). With global production of over 55 million tons per year, PET is one of the most common plastics and therefore a major component of plastic waste. Recycling methods for PET already exist today, but the quality deteriorates with each recycling process.

In their approach, the researchers in the NANOdePET project use enzymes (ester hydrolases) that break down PET. Using nanotechnological methods, they immobilize the enzymes on a silicon dioxide core and stabilize them with the help of so-called artificial chaperones. In this way, the researchers achieve better stability and higher conversion rates than with dissolved enzymes. In their application, a hybrid organic-inorganic coating of controlled thickness protects the enzymes used from external influences but allows the enzymatic cleavage of PET.

In the first year of the project, the interdisciplinary team selected various ester hydrolases and tested their PET degradation activity using different PET materials. The researchers have optimized the conditions for efficient degradation and will now compare the method they have developed with current recycling methods and investigate the method's suitability on an industrial scale.

Collaboration between: FHNW School of Life Sciences // FHNW School of Engineering and Environment // INOFEA AG (Muttenz, BL)

Project description: https://bit.ly/4gGXB7E



In the Nano-Argovia project SmartCoat, researchers are using SmartCoats™ (shown in green in the image on the right) to transport RNA-based drugs precisely and safely into cancer cells (shown with a blue-colored cell nucleus and red actin in the cytoplasm in the image on the left). The RNA fragments introduced into the tumor cells are intended to switch-off cancer-causing genes known as oncogenes, thereby reducing tumor growth. (Image: FHNW Muttenz)

Safe and targeted transport of new therapeutics into cancer cells

As part of the Nano-Argovia project SmartCoat, researchers have developed an innovative method for transporting RNA-based drugs precisely and safely into tumor tissue. This involves the use of novel nanoparticles called SmartCoats™, which protectively coat short RNA sequences known as small interfering RNA (siRNA) and introduce them directly into cancer cells.

The SmartCoats protect the siRNA from enzymatic degradation during transport and prevent unwanted reactions with immune cells. In tumor tissue, the SmartCoats then bind to specific receptors on the surface of cancer cells, allowing the SmartCoat-siRNA complexes to be taken up into the cells. Once there, the SmartCoat detaches from the siRNA, which can then "knock down" cancer-causing genes known as oncogenes and thereby reduce tumor growth.

In the second year of the project, the team used computer modelling to further optimize the SmartCoat nanoparticles. The structure of the particles is now more stable, their siRNA binding is stronger, and their uptake by cancer cells is better. Further studies can now follow under the leadership of Palto Therapeutics AG with a view to optimizing the effect of the particles on tumor growth, enabling precise and personalized treatment of life-threatening diseases such as cancer.

Collaboration between: FHNW School of Life Sciences // Paul Scherrer Institute PSI // Palto Therapeutics AG (Allschwil, BL)

Project description: https://bit.ly/4bR9s1Z

"The ongoing Nano-Argovia project with FHNW and PSI is a cornerstone of our innovation at Palto Therapeutics."
Dr. William L. Wishart,
Palto Therapeutics AG

Researchers from the UZB of the University of Basel, the FHNW School of Life Sciences and the Institut Straumann exchange ideas at regular team meetings. In this way, the researchers involved ensure effective interdisciplinary collaboration.

"We're confident that zirconium oxide-based dental implants can achieve a significant market share in the coming years. Accordingly, we're particularly interested in the results of the ZIRYT project, which has the potential to optimize both the complexity of the production process and the clinical outcomes of our products — for the benefit of patients. Our long-standing and successful collaboration with UZB, the University of Basel and FHNW reinforces our commitment to supporting these centers of excellence in their outstanding research work on an ongoing basis."
Dr. Raphael Wagner,
Institut Straumann AG

Nanostructured dental implants made of ceramics

In the Nano-Argovia project ZIRYT, an interdisciplinary team is investigating how a nanostructured surface can be used to produce ceramic dental implants made of zirconium oxide. The aim is to offer an aesthetically pleasing and metal-free alternative to titanium implants.

The researchers began by heat-treating zirconium oxide in a targeted manner to produce a nanostructured surface. Under the influence of heat, a characteristic structure forms on the surface of zirconium oxide based on the existing crystalline structure of the material. This surface structure is intended to ensure effective integration of the implant into bone.

First, the researchers developed and tested various protocols for producing the nanostructures. They then used various analytical methods to begin characterizing the different structures and completed the necessary preparations for investigating the interaction between the implant material and various cell lines in the second year of the project. By doing so, they plan to determine the ideal surface structure and define its production conditions. The project therefore aims to facilitate the production of next-generation zirconium dioxide dental implants so that they can benefit as many patients as possible.

Collaboration between: University Center for Dental Medicine Basel (UZB) // FHNW School of Life Sciences // Institut Straumann AG (Basel)

Project description: https://bit.ly/3WYIkJB

Smooth mirrors for X-rays

As part of the Nano-Argovia project CAPOFOX, researchers have developed new lithographic approaches to the production of micro-optical components from polymers. These components are known as capillary optics and consist of elongated cylindrical mirrors that precisely concentrate light on a point by means of reflection. To enable the use of both ultraviolet and X-rays, the mirrors need to have an extremely low surface roughness.

For this work, the interdisciplinary team combined aspects of tool engineering, laser technology, design and materials science to allow the production of these extremely smooth polymer structures. In the second year of the project, the researchers succeeded in determining the origins of the roughness and in producing the first components. This work will serve as the basis for producing X-ray capillaries with improved surfaces in the coming year.

Collaboration between: Paul Scherrer Institute PSI // FHNW School of Life Sciences // XRnanotech AG (Villigen, AG)

Project description: https://bit.ly/3ThvoMr

In the PICO cleanroom at Park Innovaare, researchers in the Nano-Argovia project CAPOFOX are processing light-sensitive coatings on wafers in order to subsequently produce the improved X-ray capillary optics.

"Over the last year, the CAPOFOX project has led to remarkable improvements in the reduction of surface roughness, allowing us to obtain very smooth surfaces that significantly improve our product development work. This innovative approach not only ensures high performance but also opens the door to effective future applications. We're delighted to play a part in such transformative improvements."
Dr. Florian Döring,
XRnanotech AG

In the Nano-Argovia project NanoFemto Tweezers, researchers have combined a novel femtosecond laser with nano-optical elements to create optical tweezers that can be used to assemble different cell types into biological tissue.

> **"The Nano-Argovia project NanoFemto Tweezers offers us the chance to investigate and further develop one of our innovative lasers for various novel applications — including optical tweezers, multiphoton imaging and the 3D printing of biological tissue on the micrometer scale."**
> Stephan von Wolff,
> TLD Photonics AG

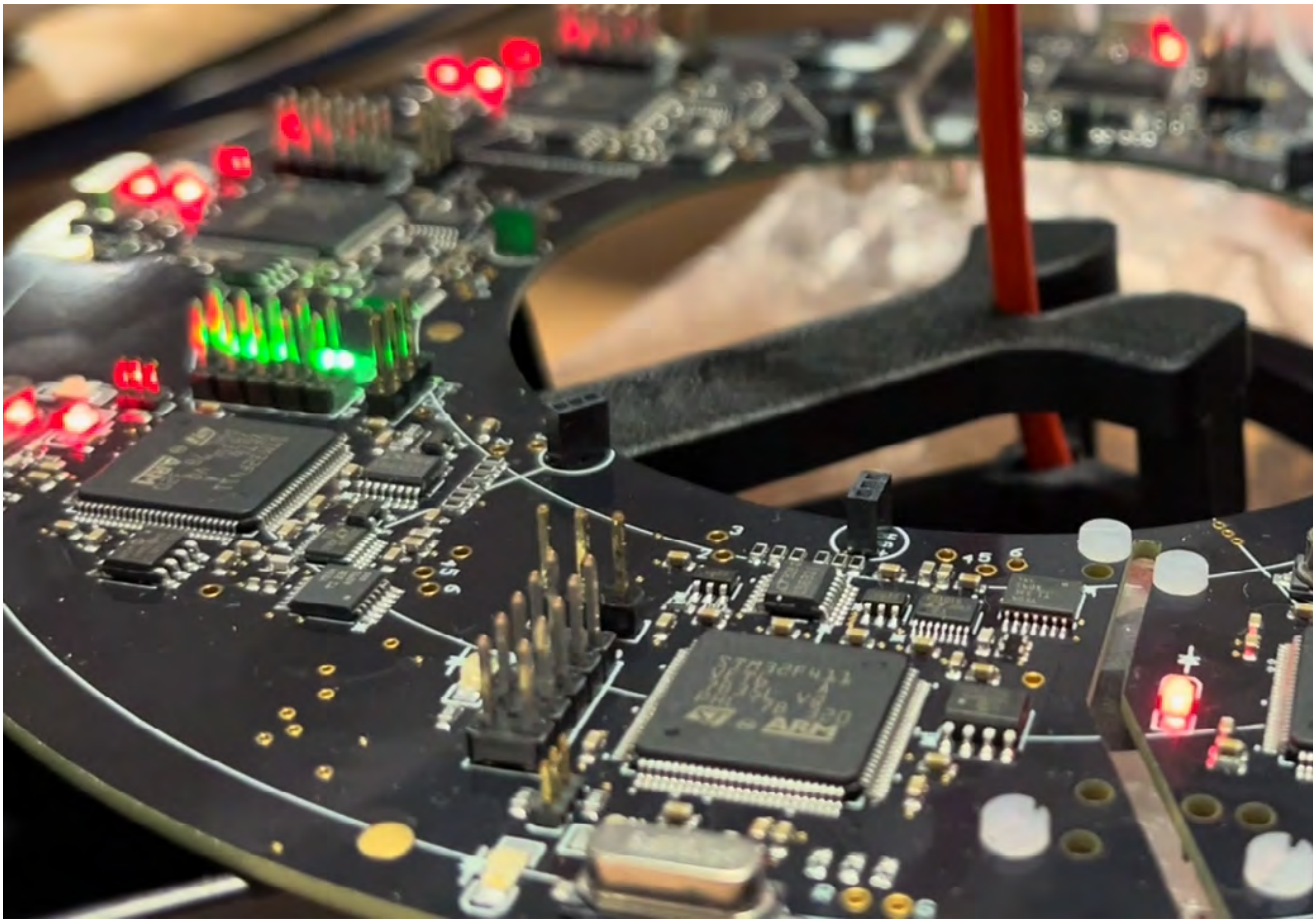
Body-on-chip thanks to efficient femtosecond lasers as optical tweezers

As part of the Nano-Argovia project NanoFemto Tweezers, researchers have developed optical tweezers that make it possible to precisely arrange different cell types – including nerve cells – in a very small space. The interdisciplinary team realized these optical traps by combining developments in femtosecond lasers and nano-optical elements.

At the end of the project's second year, thanks to the team's outstanding expertise and effective collaboration, the researchers moved microbeads and various cell types in a controlled manner – and they will soon assemble them into a complex organ system on a microscopic surface (body-on-chip) by using the developed optical tweezers as a 3D printer. In the future, this technology could be used to investigate the effect of drugs on several organ systems directly on a chip, for example.

Collaboration between: FHNW School of Engineering and Environment // FHNW School of Life Sciences // TLD Photonics AG (Wettingen, AG)

Project description: https://bit.ly/3l6gAKd



The team in the Nano-Argovia project NanoHighSens produced an improved prototype of a new type of current sensor. (Image: J. Pascal and H. Nicolas, FHNW)

Innovative current sensor to the highest quality standards

As part of the Nano-Argovia project NanoHighSens, researchers have developed a new type of current sensor that surpasses existing technologies in terms of bandwidth and resolution and sets new standards for power quality measuring devices.

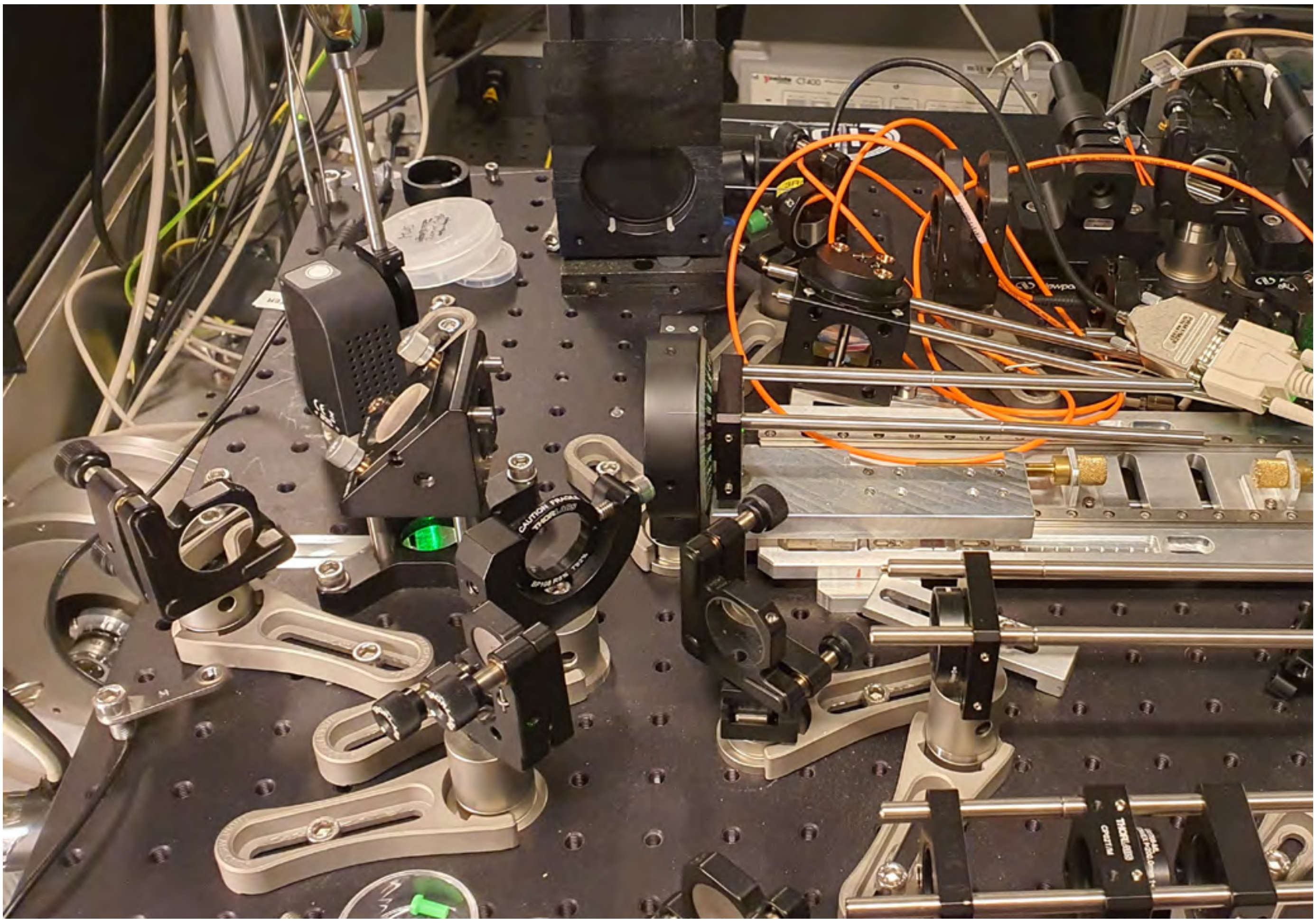
The system is based on seven small magnetometers surrounding the current conductor. Each magnetometer is based on 100 magnetic tunnel junctions placed within an area of only 100 µm x 100 µm. The improved resolution and optimized signal-to-noise ratio are achieved by averaging 100 magnetic field measurements per sensor.

In the second year of the project, the interdisciplinary team produced an improved prototype of the sensor based on the knowledge gained in the first project year and then characterized this prototype. In addition, the industrial partner Camille Bauer Metrawatt integrated and tested the device in its test area.

Collaboration between: FHNW School of Life Sciences // FHNW School of Engineering and Environment // Camille Bauer Metrawatt AG (Wohlen, AG)

Project description: https://bit.ly/48ru0uQ

"The results of the NanoHighSens project provide the fundamental basis for a new, innovative generation of electrical high-current sensors."
Max Ulrich
Camille Bauer Metrawatt AG



Researchers in the Nano-Argovia project QSBI are working on the development of a quantum sensor for studying brain activity with the help of nitrogen-vacancy centers in diamonds. As part of the project, they have built an optical laser setup to evaluate the impact of nanopatterning of the diamond surface. (Image: PSI)

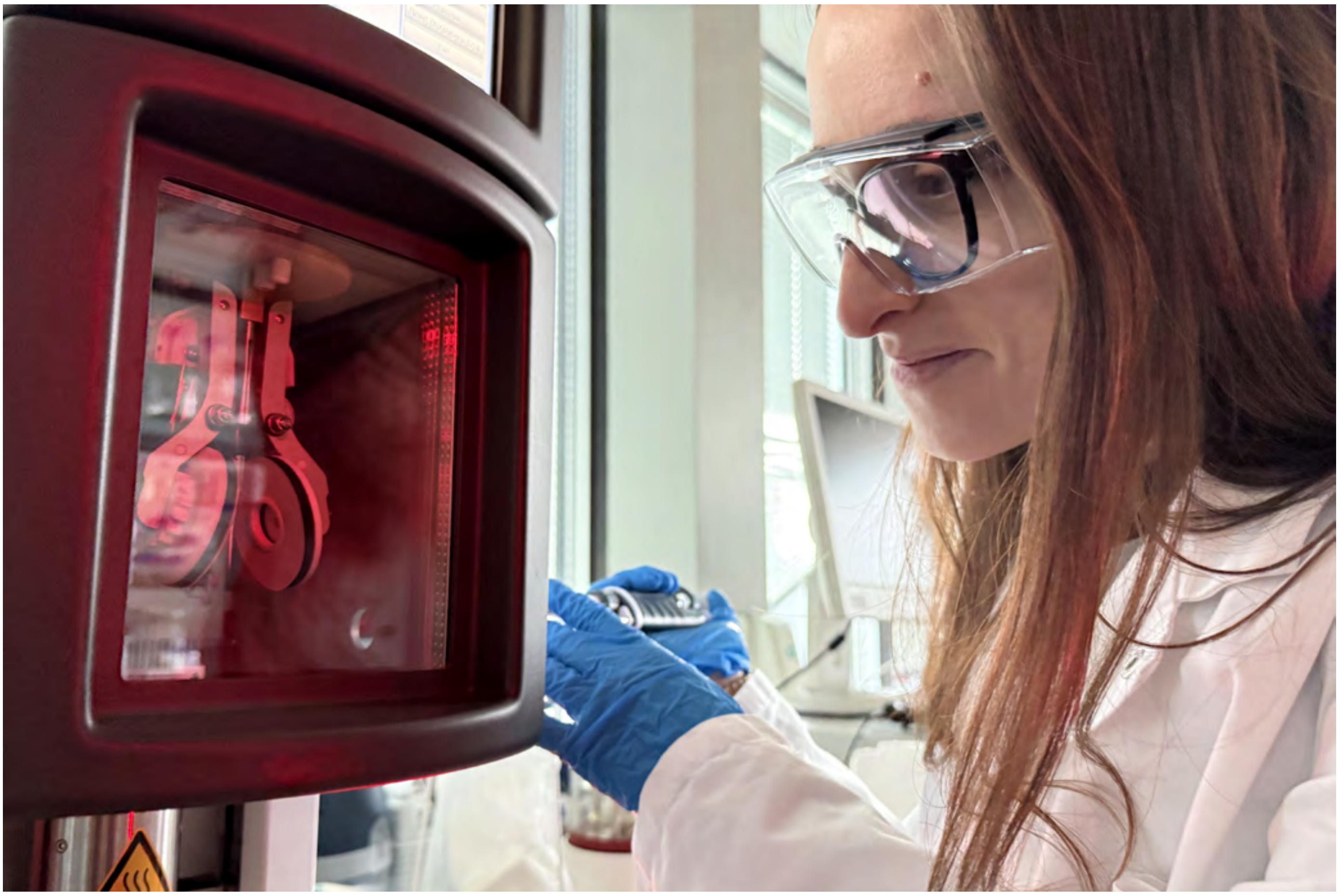
“The QSBI project was very successful and allowed Qnami to gain critical insights into several aspects of the sensor solution we’re developing. Thanks to the Nano-Argovia program, we benefited from the expert work of a multi-disciplinary consortium and made progress on both the device and software side.”
Dr. Mathieu Munsch,
Qnami AG

Quantum sensor for brain diagnostics
In the Nano-Argovia project QSBI, an interdisciplinary team investigated how brain activity can be analyzed precisely using quantum sensors based on diamonds with nitrogen-vacancy (NV) centers. The aim of the project was to improve the existing method of magnetoencephalography by using the NV centers to detect the weak magnetic fields generated by the brain. In addition, the researchers developed an algorithm that helps to create a three-dimensional map of brain activity from the measurement data.

To optimize the signal-to-noise ratio, the researchers structured the diamond surface with photonic crystals on a nanometer scale and optimized the production process. They also improved and tested algorithms for machine learning. This makes it easier to process the data, enabling a highly accurate and robust reconstruction of 3D brain activity.

Collaboration between: Paul Scherrer Institute PSI // CSEM SA Allschwil // Qnami AG (Muttenz, BL)

Project description: https://bit.ly/47BuEFD



In the Nano-Argovia project ProtEDinNanoxtals, the researchers first produce nanocrystals. These are then used to create a detailed diffraction pattern that shows the exact arrangement of the atoms in the protein molecule.

Electron diffraction for protein structural biology

The Nano-Argovia project ProtEDinNanoxtals uses electron diffraction to unlock the secrets of hydrogen atoms' roles in protein function and the interactions between proteins and ligands. This cutting-edge experimental research aims at shedding light on the atomic-level structure of proteins, paving the way for a deeper understanding of essential biological processes and driving innovation in drug development.

Using high-energy electrons, the team generates detailed diffraction patterns that will reveal the precise arrangement of atoms from thousands of protein molecules arranged in a nanocrystal. This pioneering approach will enable the decoding of molecular structures with unparalleled precision, especially with regard to the position of hydrogen atoms.

To validate and refine their method, the researchers need first to explore a range of well-characterized model proteins of varying sizes and functions. A first milestone was reached with electron diffraction images to 1.2 Å resolution. The team of experts in physics and biology will concurrently and progressively improve both the electron microscope settings and the samples, and will establish a pipeline to ultimately analyze pharmaceutically significant membrane proteins – an ambitious step toward understanding these critical biomolecules. Locating the position of hydrogen atoms in membrane protein is currently beyond the realm of other experimental techniques including both X-ray crystallography and cryo-EM.

In the future, additional membrane proteins will be studied, broadening the use of the electron diffraction technique and offering streamlined sample preparation. By contributing their

"Electron diffraction shows potential as a vital complementary technology for nanocrystals, providing additional structural detail such as the position of hydrogen atoms. This information is crucial to the design of better drugs for membrane protein targets."
Dr. Robert Cheng, leadXpro AG

Electron diffraction can be used to elucidate the structure of nanocrystals. In the Nano-Argovia project ProtEDinNanoxtals, the researchers also want to analyze the position of hydrogen molecules in membrane proteins.

"ELDICO was the first company to make commercially available systems dedicated to electron diffraction crystallography. In this project, jointly with our partners, we will be now driving the technology further."
Dr. Gunther Steinfeld,
ELDICO Scientific AG

findings to under-represented structural databases, the consortium is not only filling vital gaps in scientific knowledge but also propelling the discovery of new therapeutic agents. With their results, they are also helping to uncover the mechanisms of action of potential active pharmaceutical ingredients.

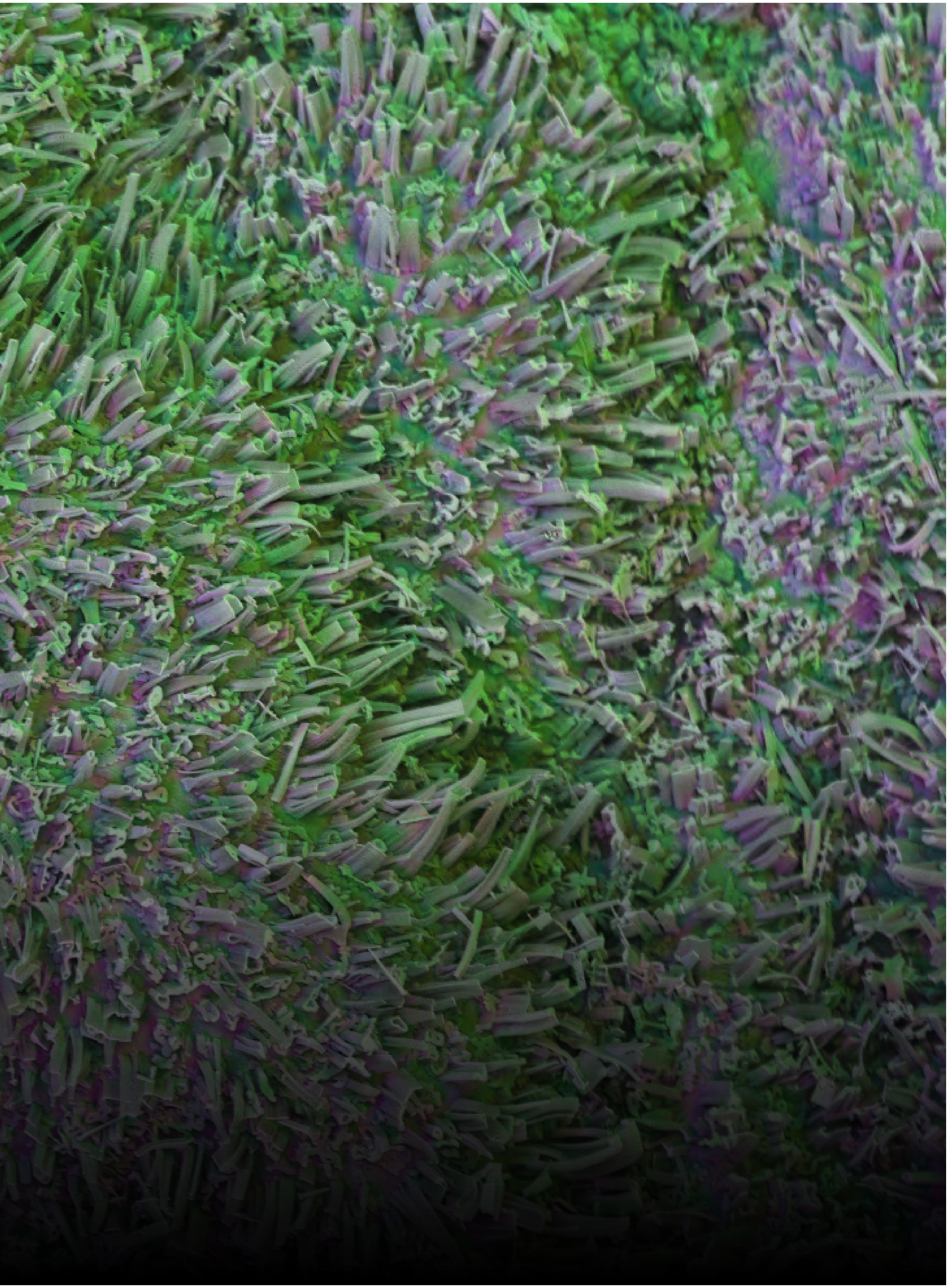
Collaboration between: Paul Scherrer Institute PSI // Biozentrum, University of Basel // leadXpro AG (Villigen, AG) // ELDICO Scientific AG (Villigen, AG)

Project description: https://bit.ly/3Qh8wdq

Service, research and teaching

The members of the Nano Technology Center offer an excellent service in the field of nanoimaging and nanofabrication. They are also involved in research projects and train young scientists.

During one of the block courses in the Nano Imaging Lab, Natalie Walser took this picture of the surface of kale and submitted it for the Nano Image Award competition 2024.



Nano Technology Center: Partners in research and teaching

In the future, the SNI's focus will be on the areas of nanoimaging and nanofabrication. A key part of this orientation is the Nano Technology Center, which was founded in 2022 and consists of the Nano Imaging Lab (NI Lab) and the Nano Fabrication Lab (NF Lab). These two groups are available both to partners from the network and to external customers in order to provide services and engage in research partnerships.

The teams continually expand and renew their infrastructure in order to meet the requirements of customers, to remain competitive and to keep up with the state of the art. Both groups are also engaged in teaching and outreach activities and make a key contribution to bringing insights into the micro and nanoworld to a wide audience.

In 2024, the Nano Imaging Lab, with its six members of staff led by the nanoscientist Dr. Marcus Wyss, processed 180 orders from 130 different customers. Of these wide-ranging projects, which often lasted several days or weeks, 86% originated from within the SNI network or from external research institutions, while some 14% were commissioned by national and international industrial companies.

The laboratories and clean rooms of the Nano Fabrication Lab were used by 73 different users in 2024. Led by physicist Dr. Gerard Gadea, the lab's four-person team enabled researchers from a total of 10 research groups from the University of Basel and from two companies to carry out wide-ranging projects at the Nano Fabrication Lab. In 2024, the team also trained two new members of staff and focused on optimizing organizational procedures and improving communication with users.

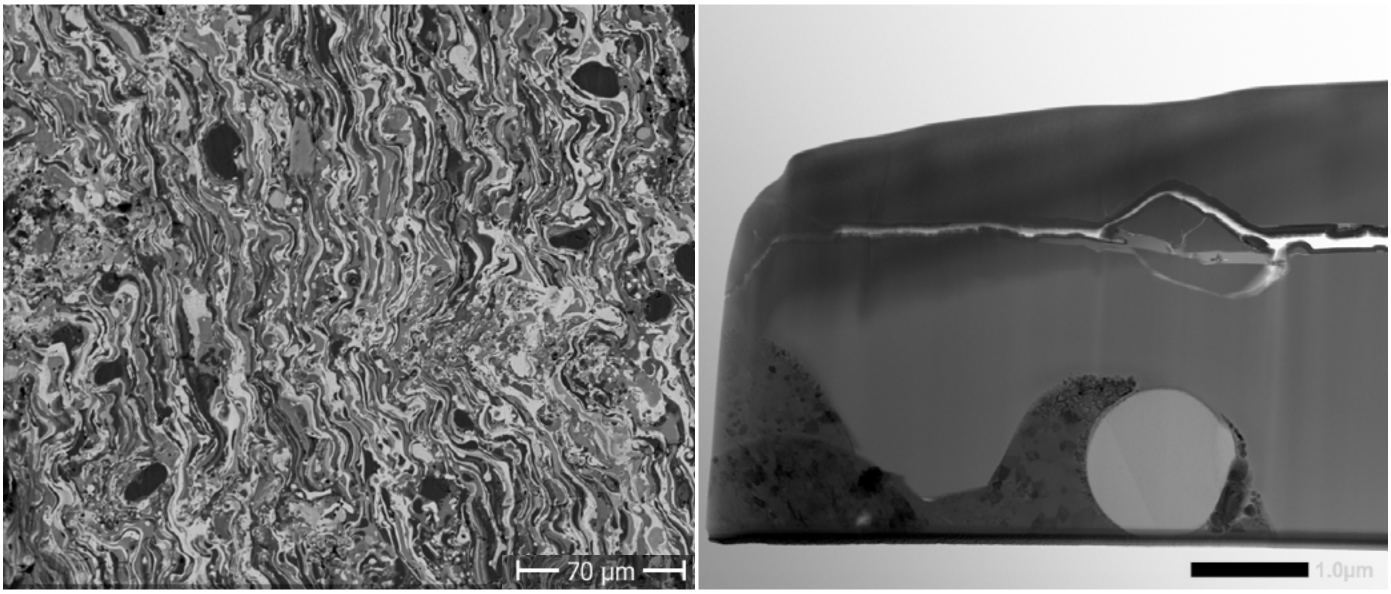
Nano Technology Center: https://nanoscience.unibas.ch/en/services/

Alexander Vogel from the NI Lab takes the first measurements using the new scanning electron microscope.

Nano Imaging Lab
A valuable partner for research

In 2024, the Nano Imaging Lab (NI Lab) helped numerous research groups with the imaging, analysis and modification of nanoscale structures. The team provided valuable support to researchers seeking to answer questions that were not only relevant to companies but also led to several interesting publications. Overall, the tendency for the Nano Imaging Lab to evolve from a pure service unit into a valuable partner for research grew stronger in 2024 – as demonstrated by the greater number of scientific publications involving NI Lab staff.

In collaboration with the ANAXAM Technology Transfer Center, for example, the NI Lab was able to apply its expertise relating to the analysis of ceramic coatings for medical devices from a materials science perspective. This project revolved around a new ceramic coating with the three components aluminum oxide (Al_2O_3), titanium dioxide (TiO_2) and zirconium dioxide (ZrO_2). This coating was applied to a titanium alloy using a special technique known as atmospheric plasma spraying. For Gulhfi AG (Wohlen, AG), an international manufacturer of surface technology, it was then important to clarify the robustness of these new coatings under loading.



The team from the NI Lab used an ion beam to cut the new coating (left: top view) into sections, which they analyzed using a transmission electron microscope (right: cross section of coating). Researchers were then able to identify the different components using energy-dispersive X-ray analysis (EDX). (Image: Nano Imaging Lab, SNI, University of Basel)

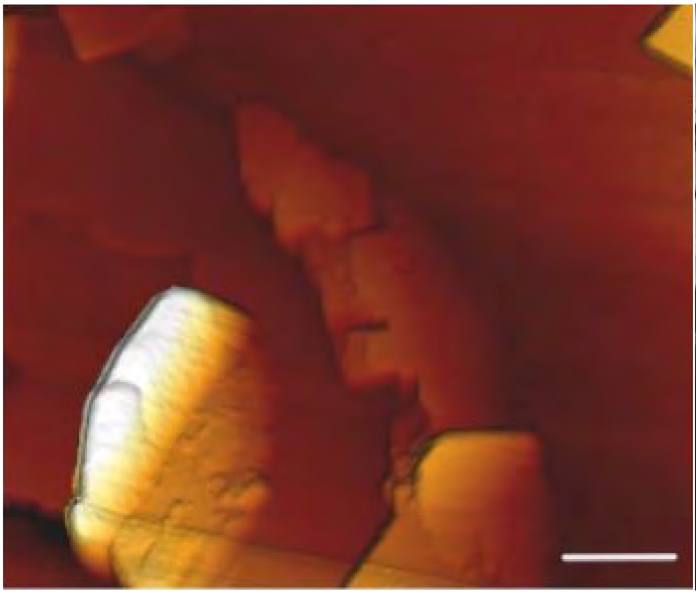
The NI Lab's analyses led to the identification of the crystal structure of the two key phases (alpha-Al_2O_3 and m-ZrO_2). Further analyses by Professor Michael de Wild at the FHNW School of Life Sciences then demonstrated that the 400-micrometer-thick coating was highly resistant and remained intact even when subjected to scratch testing. The coating is therefore of particular interest for use in high-wear applications – such as medical devices.

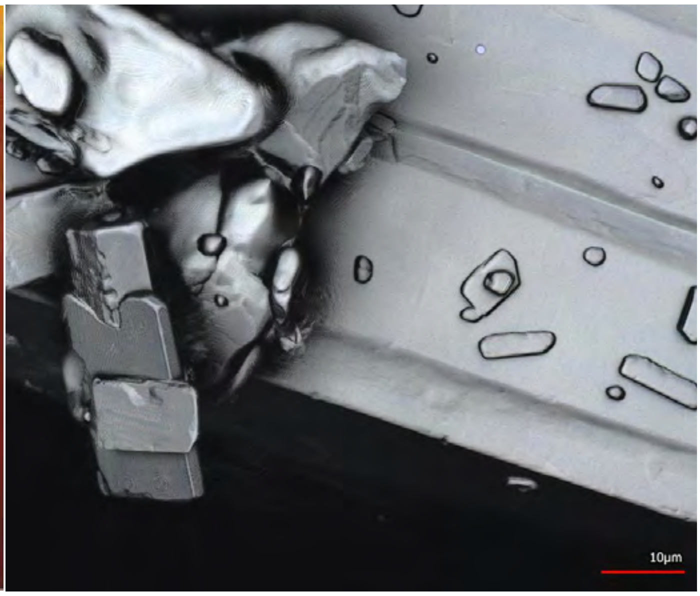
In collaboration with Professor Martin Kuentz from the FHNW School of Life Sciences, the Nano Imaging Lab made a key contribution to drug development in a project centering around pharmaceutical formulations that were difficult to keep stable in the amorphous (glass-like) state. The aim was to design a computational strategy that could be used to select suitable additives for stabilization before the drug is actually developed.

With a view to analyzing these predictions experimentally, the researchers tested two active ingredients, which were pressed into an elongated shape together with a polymer and two additives (dl-malic acid and l-acetic acid) using a technique known as hot-melt extrusion before being placed in storage. The team from the NI Lab used laser and atomic force microscopes to examine the surfaces of the various products, allowing researchers to make an informed evaluation of the best active ingredient-polymer mixtures in terms of stability and durability.

For years, the NI Lab has been engaged in trinational projects relating to sustainable viticulture. In 2024, as part of the WiVitis project launched in 2023, researchers in Basel analyzed the surface properties and structure of waxes found on the berries of certain fungi-resistant vine varieties. These analyses aimed to further the development of concepts that help wineries tackle the challenges of climate change.

The instruments used at the NI Lab must be continuously renewed and expanded with a view to not only constantly improving the lab's services and its own research but also adapting the infrastructure in line with demand. In 2024, the NI Lab team installed and commissioned a new scanning electron microscope (Zeiss FIB-SEM Crossbeam 540), which is equipped with a focused



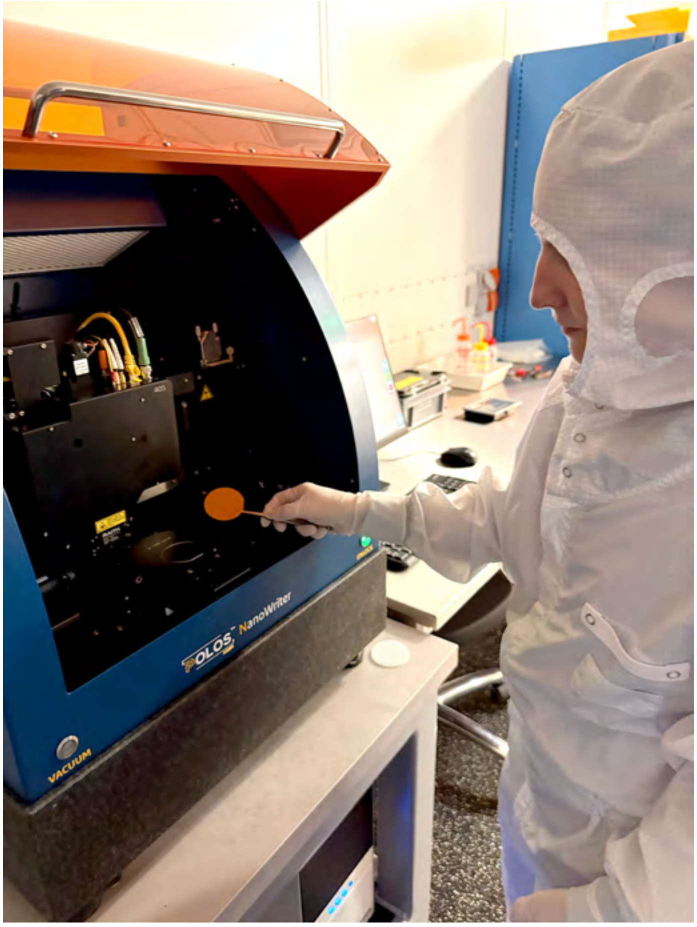


ion beam (FIB). This enables the high-resolution visualization of micro and nanostructures and allows the accurate machining of materials, such as to create the precise sections needed to produce ultrathin samples for transmission electron microscopy. The microscope allows the NI Lab team to meet the requirements of various different disciplines, such as quantum, materials or environmental science or the life sciences.

The NI Lab team used atomic force microscopy (left) and 3D laser scanning microscopy (right) to examine the surface of various compositions of solid drug formulations, helping researchers evaluate the best active ingredient-polymer mixture in terms of stability and durability. (Image: Nano Imaging Lab, SNI, University of Basel)

"Many new drug candidates can only be developed into a finished dosage form with the help of special formulation techniques. On multiple occasions during applied research into these dosage forms, the Nano Imaging Lab helped us to gain a better understanding of formulations and to identify practical stability problems in good time using various different analyses."
Professor Martin Kuentz,
FHNW School of Life Sciences

"The electron microscopy facilities at the SNI make an important contribution, acting as a complement to ANAXAM's material analytics."
Dr. Christian Grünzweig,
ANAXAM Technology Transfer Center



Nano Fabrication Lab

Point of contact for the production of tiny structures

The staff of the Nano Fabrication Lab largely carry out their work in clean rooms belonging to the NF Lab. These facilities provide controlled conditions with minimized particle concentrations that are essential for the production and machining of micro and nanostructured materials.

In 2024, work at the Nano Fabrication Lab (NF Lab) was carried out by over 70 researchers from the University of Basel and from the two companies Nanosurf and Qnami. Although researchers use the lab's instruments largely independently, they are reliant on the NF Lab team's experts when it comes to the intensive training, servicing and maintenance work on these heavily used instruments, which play a vital role in their research projects.

For the four-person NF Lab team, 2024 was dominated by the training of two new part-time employees and the improvement of organizational structures. For example, responsibilities for the diverse range of equipment were redistributed within the team, so that tasks such as maintenance, repair and the training of new users are now spread across the four members of staff. The team also introduced a new accounting system that allows for fairer billing of costs arising as a function of instrument use – based on the cost per hour or cost per process. Moreover, the team implemented improved guidelines on cleanliness and safety in the clean room in 2024, reducing the particle concentration and the risk of accidents.

The year 2024 also saw the team improve various aspects of communication. For example, since the section of the NF Lab's clean room space that entered operation in 2023 is located in the building of the Department of Biosystems Science and Engineering of ETH Zurich in Basel (D-BSSE), there are regular meet-

> **"The NF Lab and other partners help us to obtain the best possible nanopore chips for our highly sensitive experiments with single-molecule resolution."**
> Professor Sonja Schmid,
> Department of Chemistry,
> University of Basel

The metal evaporator installed in 2023 is now a much-used device at the Nano Fabrication Lab and requires frequent cleaning and servicing by NF Lab staff so that it is available to users at all times.

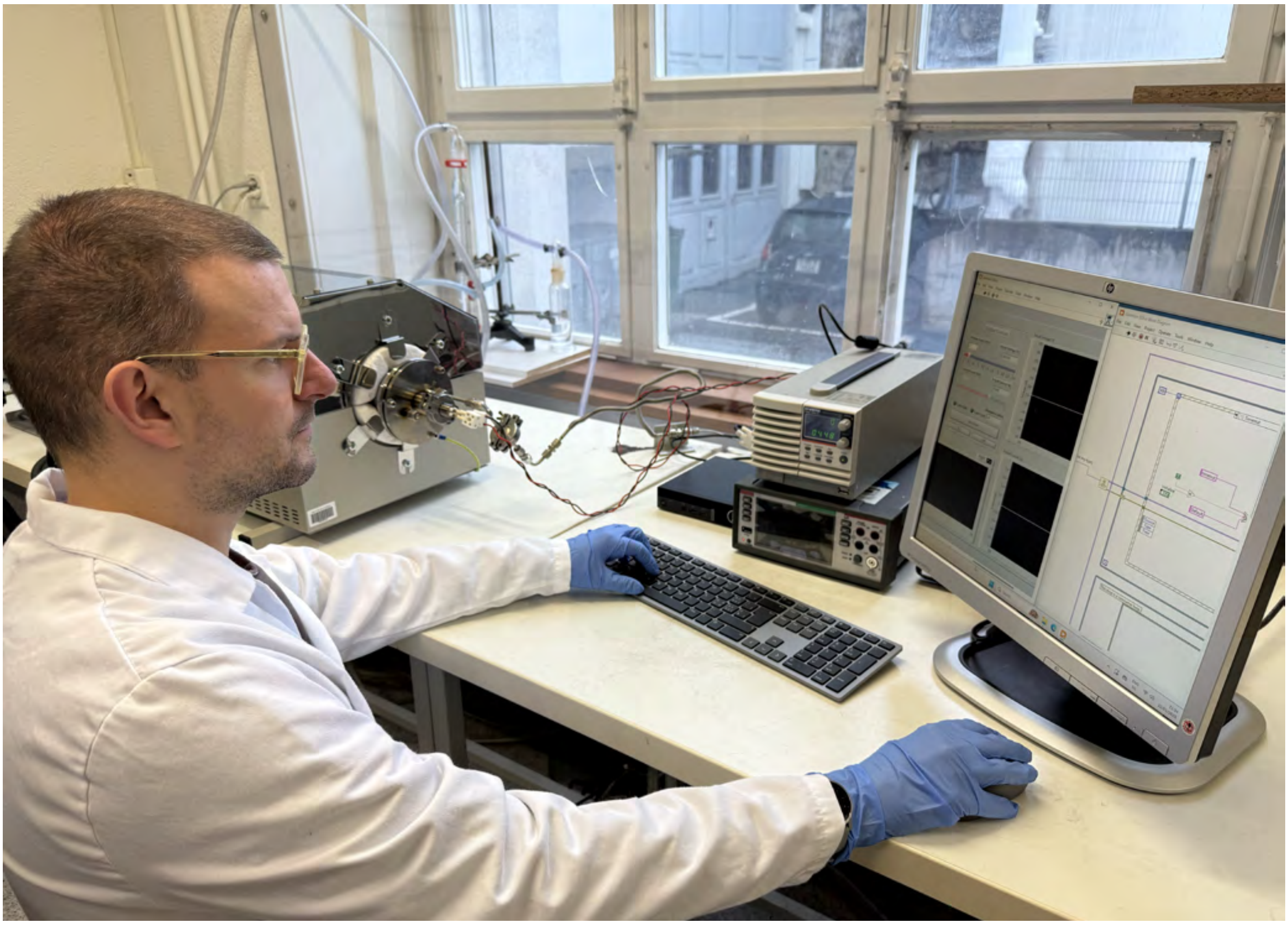
> **"We're one of the main users of the NF Lab, and our research is dependent on the lab. We particularly benefit from the opportunities provided by the new instruments for electron beam lithography and metal evaporation."**
> Professor Andrea Hofmann, Department of Physics, University of Basel

ings between the head of the Nano Fabrication Lab, Dr. Gerard Gadea, and D-BSSE's clean room managers. Regular discussions also take place within the team, with all of the lab's users, and with the professors from the Department of Physics, helping the NF Lab team to ensure that they can respond quickly to unresolved questions, problems and requirements. The lab has also succeeded in improving its visibility and presenting itself as an open platform for collaboration by publishing a price list setting out the costs of using its instruments for external users and by introducing a new team email address (sni-nflab@unibas.ch) as well as a shorter website URL (nanofabrication.unibas.ch).

Researchers use the Nano Fabrication Lab to work on wide-ranging projects. Although they use various different instruments and require different forms of assistance, the NF Lab team is on hand to help all of them with a view to creating the best possible conditions for their work.

The group led by Professor Sonja Schmid (Department of Chemistry) produces chips with glass nanopores at the NF Lab in order to investigate the dynamics of individual molecules. Although there are established, standard nanofabrication procedures for silicon chips, these procedures have several disadvantages when it comes to the desired applications. Producing the nanopore chips from glass requires a certain degree of adaptation, which the NF Lab helps the researchers achieve.

The team led by Professor Andrea Hofmann (Department of Physics) uses the NF Lab to produce various nanoscale samples, which they then put to use in their quantum research. These samples include semiconductor quantum dots, Josephson junc-



tions and one-dimensional channels in bilayer graphene. The NF Lab provides the researchers with the clean environment they need in order to produce these samples.

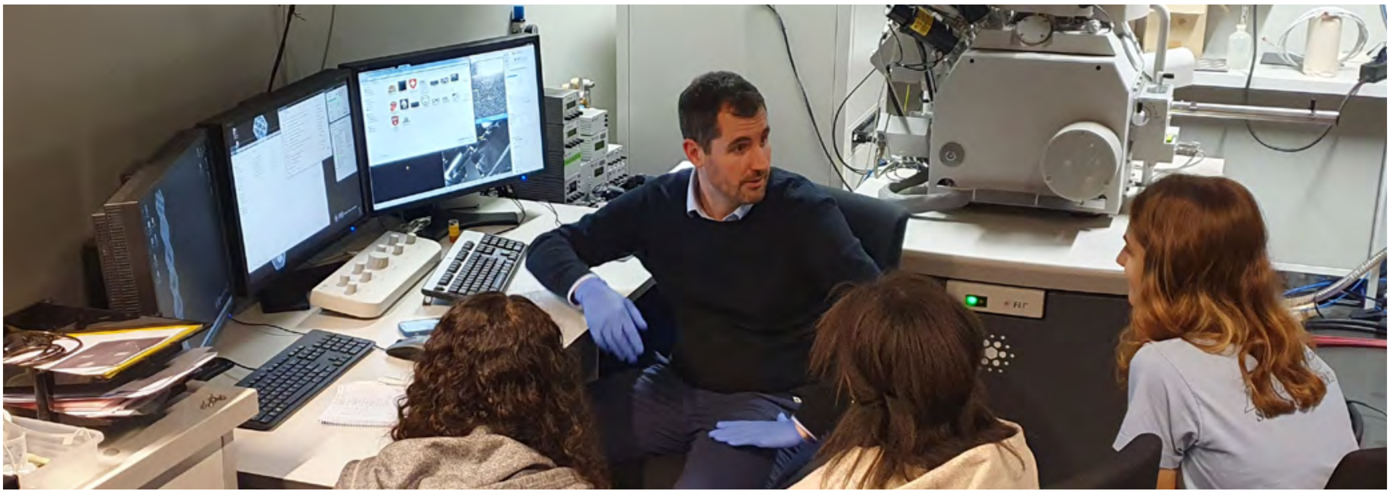
Over the last year, the Quantum Sensing group led by Professor Patrick Maletinsky (Department of Physics) made intensive use of the NF Lab in order to produce and further optimize nanoscale quantum sensors, whose principal application is in qualitative magnetic imaging on the nanoscale. For example, the sensors are used in the development and improvement of novel magnetic storage media for computer applications and to analyze interesting new magnetic materials. Work at the NF Lab focused on achieving further improvements in the sensors' performance, functionality and robustness.

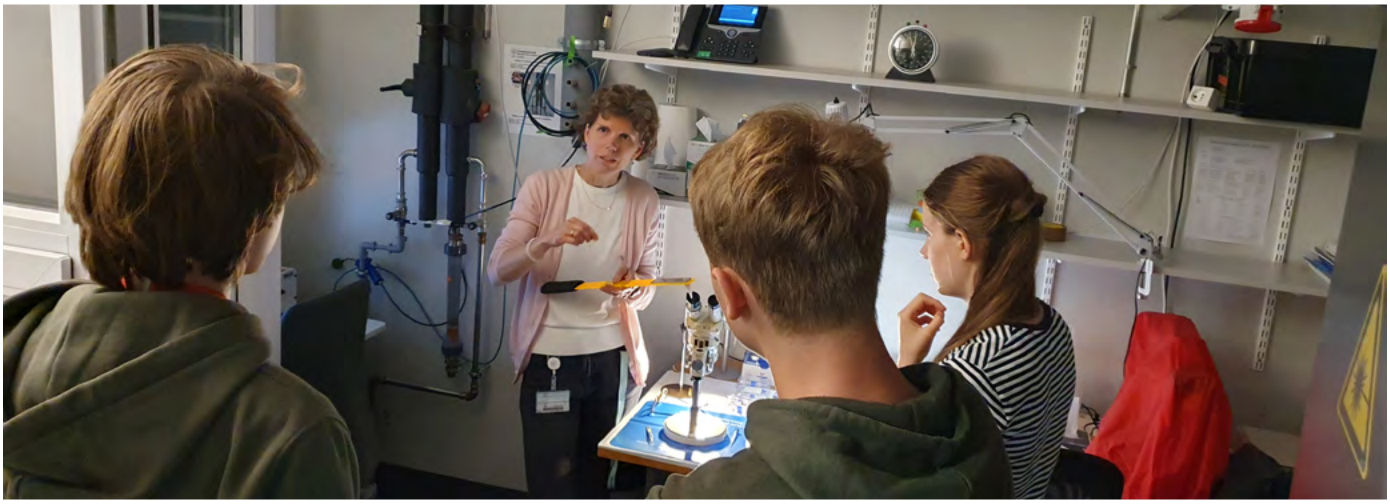
The two companies Nanosurf and Qnami were also active at the NF Lab in 2024. Nanosurf worked on the preparation of semiconductor chips that are then characterized using state-of-the-art industrial atomic force microscopes for wafer metrology.

Overall, the establishment of the Nano Fabrication Lab in 2022 is greatly appreciated by users, as the team allows researchers to focus on their research.

Researchers can use the heating furnace to improve the properties of components from the quantum sciences, such as silicon-germanium qubits or quantum sensors based on nitrogen-vacancy centers in diamonds.

"The team of the Nano Fabrication Lab is invaluable for our research at the interface between quantum and nanotechnology. They not only ensure that the instruments are always in reliable working order, but also actively support us in further developing and optimizing our nanofabrication processes. The team has therefore played a key role in driving forward our research projects, while also allowing my group members to concentrate fully on their scientific work instead of spending time on maintaining instruments at the NF Lab."
Professor Patrick Maletinsky,
Department of Physics,
University of Basel



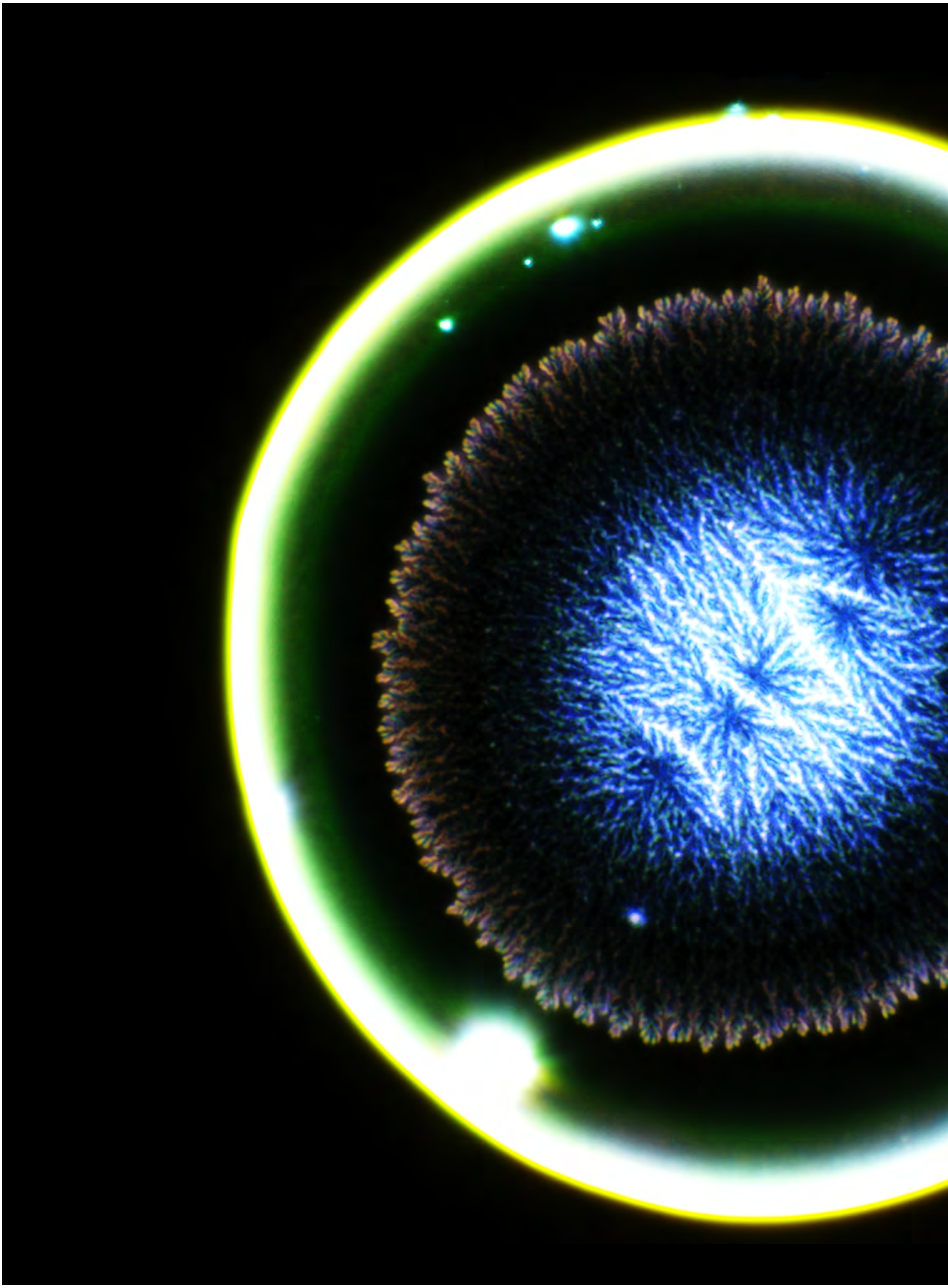


The event "TecDay meets Swiss NanoConvention" welcomed groups of schoolchildren to the SNI's Nano Technology Center in June 2024. Here, Marcus Wyss and Monica Schönenberger explained various methods used by the Nano Imaging Lab to image and analyze the micro and nanoworld. (Image: Nano Imaging Lab, SNI, University of Basel)

Nano Technology Center
Active in teaching and outreach

The two teams from the NI Lab and the NF Lab also play an active role in teaching and SNI outreach programs. In 2024, the Volkshochschule beider Basel (VHSBB) offered a series of talks and an excursion to the NI Lab in collaboration with the SNI. The course was well received by all participants and is to be repeated in fall semester 2025. In 2024, the two groups gave the Baselland Nature Research Society (NGBL) a tour of the Nano Technology Center. Other visitor groups were also warmly welcomed over the course of the year and, thanks to the team's efforts, gained fascinating insights into the imaging and fabrication of micro and nanostructures.

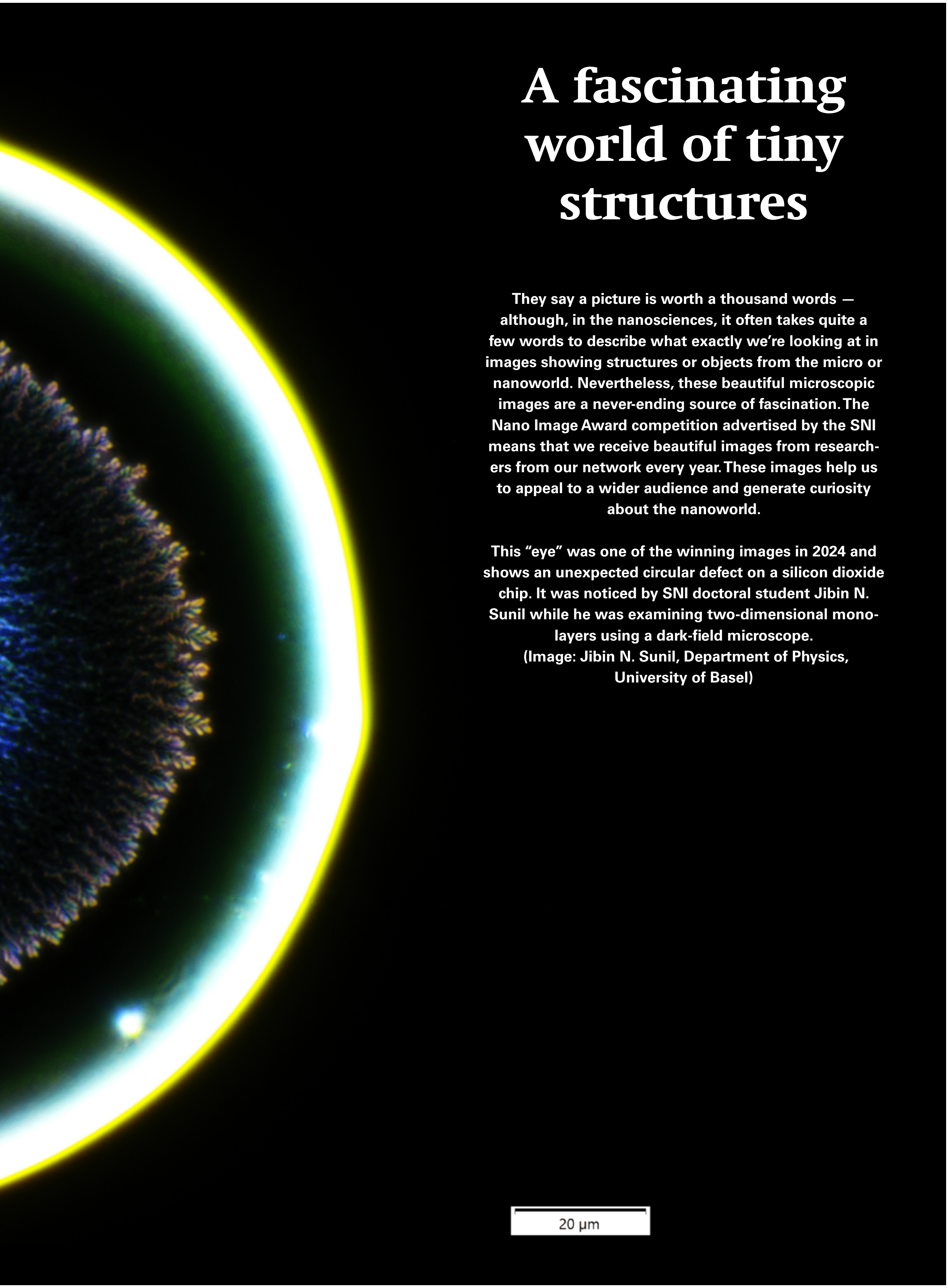
Since 2024, the two team leaders Gerard Gadea and Marcus Wyss have offered a lecture course on nanoimaging and nanofabrication for bachelor's and master's students. Moreover, students of biology and the nanosciences have the opportunity to immerse themselves deeper in the topic of nanoimaging as part of a block course. In 2024, the NI Lab team restructured these courses and produced an extensive handbook. Another highlight of the year was the User Event, which was attended by over 40 participants. Organized by the NI Lab on an annual basis, this event provides current and potential users with insights into the lab's wide-ranging analytical capabilities.



A fascinating world of tiny structures

They say a picture is worth a thousand words — although, in the nanosciences, it often takes quite a few words to describe what exactly we're looking at in images showing structures or objects from the micro or nanoworld. Nevertheless, these beautiful microscopic images are a never-ending source of fascination. The Nano Image Award competition advertised by the SNI means that we receive beautiful images from researchers from our network every year. These images help us to appeal to a wider audience and generate curiosity about the nanoworld.

This "eye" was one of the winning images in 2024 and shows an unexpected circular defect on a silicon dioxide chip. It was noticed by SNI doctoral student Jibin N. Sunil while he was examining two-dimensional monolayers using a dark-field microscope.
(Image: Jibin N. Sunil, Department of Physics, University of Basel)



Network: Achieving joint goals through interdisciplinary collaboration

The SNI is an interdisciplinary network in which researchers from various research organizations in Northwestern Switzerland carry out research into the nanosciences and nanotechnology in order to drive advances for the benefit of the general public.

Partner institutions belonging to the network include the University of Basel, with its Departments of Biomedicine, Chemistry, Physics, Pharmaceutical Sciences and Environmental Sciences and the Biozentrum; the FHNW School of Life Sciences in Muttenz and School of Engineering and Environment in Windisch; the Paul Scherrer Institute; the Department of Biosystems Science and Engineering of ETH Zurich in Basel; the Centre Suisse d'Electronique et de Microtechnique (CSEM) in Allschwil; and the technology transfer centers ANAXAM and Swiss PIC. The broader network also includes the Hightech Zentrum Aargau in Brugg and Basel Area Business & Innovation, with whom we collaborate to promote knowledge and technology transfer.

In 2024, the management team worked with internal and external experts to develop a strategy for the next 10 years of the SNI network. One key pillar of this strategy is to reinforce collaboration between SNI members across the boundaries of different disciplines and institutions. This goal will benefit from events organized by the SNI management as well as optimum networking and a regular exchange of information among members.

Strategy 2024–2034

Geared toward a successful shared future

At the end of May 2024, the Argovia Committee approved the strategy paper for 2024–2034. It was developed with the involvement of the SNI management, external and internal experts, and members of the SNI Executive Committee. Using this strategy as a guide, the SNI will position and establish itself over the coming years so that we can put our extraordinary expertise in the nanosciences and nanotechnology to use in addressing the challenges facing society – and make the SNI a lighthouse for research, education and innovation in the nanosciences. The key guiding principles for achieving our goals are to focus, collaborate, adapt and impact.

Over the next decade, the SNI will focus on the core areas of nanoimaging and nanofabrication by building on our roots and experience while steadily consolidating and expanding our infrastructure and knowledge in these areas. We will involve all areas of the SNI – including fundamental and applied research, the service units (the Nano Technology Center) and the educational program – within this focus in order to help overcome challenges in the fields of materials science, quantum science, the life sciences, medicine and the environment.

Close collaboration by all partners is vital for the success of an interdisciplinary network such as the SNI. The aim for the future is to strengthen identification with the SNI network among its members, to create a stronger sense of "we" and to communicate the SNI's achievements together.

In order to compete with the best nanoscience centers in the world, we must adapt our infrastructure to the ever-increasing technological demands of the coming years. We will also continue to modernize the training of young scientists and make the way in which we present information about our activities increasingly more attractive.

On the one hand, the SNI's work will impact society through successful research on issues for which nanotechnologies offer solutions. On the other hand, it will have an impact by providing specialized services beyond the network and, lastly, by training excellent young scientists and active outreach.

Strategy paper 2024–2034: https://bit.ly/3WY3Dts

Video on the SNI's strategy featuring members of the Executive Committee: https://youtu.be/oolNp3M1ngU

For the SNI, the development of its Strategy 2024–2034 began with a workshop to which we invited internal and external experts from various nanocenters.

The NanoTec Apéro (top left), the Swiss NanoConvention and the SNI Annual Event (bottom right) focus on the exchange of ideas regarding current research projects and the making and strengthening of contacts.

Active networking

Bringing researchers together for information and exchange

Within the SNI network, interdisciplinary exchange takes place on various levels. Project teams meet regularly to discuss their respective lines of research. Meetings are also essential at a cross-institutional level so that SNI members have the opportunity to discuss and generate ideas for collaborative projects. Once a year, all members come together for the Annual Event, which has been held at Lake Hallwil in the Canton of Aargau since 2023. Running from Wednesday to Friday, the event includes scientific talks by doctoral students and project leaders, who discuss their research with one another as part of a poster session and benefit from numerous opportunities to make new contacts and refresh old ones.

Held on an annual basis, the NanoTec Apéro revolves specifically around the applied Nano-Argovia projects in collaboration with industry. This is always an inspiring event and was hosted by Park Innovaare in 2024. As well as talks and posters on current projects, which showcased the excellent collaboration between industry and research institutions, the around 70 participants particularly valued the tours of the Paul Scherrer Institute that were organized as part of this year's event.

The annual Swiss NanoConvention (SNC) provides opportunities for networking beyond the borders of the SNI network – particularly when the SNI organizes the convention in Basel and can use invitations to cultivate contacts with international researchers. In 2024, the SNI team once again succeeded in bringing together leading scientists from Switzerland and abroad and in organizing an inspiring SNC with some 300 participants.

The SNI team uses various platforms to disseminate information within the network. As well as being active on various social media channels, the SNI regularly reports on projects and activities via the online magazine SNI INSight. In 2024, the SNI incorporated a section on funding grants into the magazine to share details of the wide-ranging research projects of SNI members and also encourage exchange and new collaborations.

Highlights from the NanoTec Apéro: https://youtube.com/shorts/tDm5riP0UFo

Report on the Swiss NanoConvention: https://bit.ly/4ijdCC9
Video Swiss NanoConvention: https://youtu.be/d2SxVeCabT0

Awards and honors

Christoph Gerber named Clarivate Citation Laureate

This year, our honorary member Professor Christoph Gerber (Department of Physics, University of Basel) was named a Clarivate Citation Laureate for the invention of the atomic force microscope. Every September, the media group Clarivate (UK) publishes a list of scientists who are considered potential future winners of a Nobel Prize due to frequent citations of their work in high-ranking scientific journals.

Further information: https://clarivate.com/citation-laureates/winners/

Distinction and emeritus status for Christian Schönenberger

In 2024, our long-standing director and honorary member Professor Christian Schönenberger (Department of Physics, University of Basel) was honored by the American Physical Society (APS) as one of the APS Outstanding Referees for 2024. A farewell event was held in November 2024 to mark Professor Schönenberger's retirement. Numerous long-standing colleagues who had accompanied him during his successful career took part in the event in order to wish him well in this new stage of his life.

Young Fluorescence Investigator Award for Sonja Schmid

In February 2024, Professor Sonja Schmid (Department of Chemistry, University of Basel) received the Young Fluorescence Investigator Award 2024 from the Biological Fluorescence Subgroup in recognition of her work in the area of fluorescence methodologies.

Further information: https://bit.ly/40plg5q

Ruzicka Prize for Murielle Delley

Professor Murielle Delley (Department of Chemistry, University of Basel) is to receive the Ruzicka Prize 2024 for her work on the controlled surface modification of cobalt phosphide with sulfur.

Further information: https://bit.ly/4gWIx63

Wide-ranging grants for new research projects

In 2024, SNI members were again very successful at attracting grants from national and international sources. We've been reporting on the various new research projects in our online magazine, SNI INSight, since 2024 in order to encourage exchange within the network.

Grants for new research projects in the first half of the year: https://bit.ly/4gTZ3E5
Grants for new research projects in the second half of the year: https://bit.ly/40U4dtK

Communication and outreach: Promotion of dialog between research and society

One key task of the Swiss Nanoscience Institute is to help a wider audience understand the fascinating world of the nanosciences and their diverse applications. The SNI team therefore presents these often complex and demanding topics in a clear and attractive manner with a view to generating interest and encouraging discussion on an ongoing basis.

Through a combination of tried-and-tested formats such as Science Days, school visits, public talks, workshops and laboratory tours, the SNI team ensures that people of all ages and backgrounds have access to nanoscience topics. Moreover, the SNI is always taking up opportunities to test new formats for specific target groups. For example, the program for 2024 included an event called "TecDay meets Swiss NanoConvention" for high-school students from across Switzerland.

As well as events centering around personal contacts, the SNI also focuses on digital communication. Our extensive and well-visited website and the increasing reach of our social media channels reflect the growing impact of our wide-ranging content. By the end of 2024, over 7,000 people and organizations were following the SNI's social media channels on LinkedIn, X, Bluesky, Instagram and YouTube.

Thanks to this multifaceted approach, the SNI is able to communicate scientific content in an entertaining way and thereby help people understand the relevance of the nanosciences in research and everyday life.

At the Rüeblimärt, in the lab, in the lecture room or online

Different formats for different target groups

In 2024, the SNI team once again used different platforms to engage with different target groups, inform them about the nanosciences, and generate interest in the natural sciences in general. At the start of the year, for example, there was a collaboration with Volkshochschule beider Basel in which researchers from the SNI network offered participants insights into their various fields of science over the course of five days. The year 2024 was also the first time that the SNI took part in the Global Science Film Festival, where a six-minute video on the development of the atomic force microscope and several current applications was shown to a full house at the Stadtkino Basel movie theater. Researchers from the University of Basel were the target group for a didactics workshop that the SNI team organized and in which Professor Gerald Feldman (George Washington University, Washington, D.C., USA) shared innovative approaches to the communication of scientific content.

The event tunBasel addressed a young audience, as did the numerous workshops with students from various high schools in Northwestern Switzerland. Sixty high-school students were delighted to attend “TecDay meets Swiss NanoConvention” – an event organized by the SNI together with the Swiss Academy of Engineering Sciences SATW as part of the Swiss NanoConvention (SNC). The students could choose between various modules, in which researchers gave them an introduction to different aspects of the nanosciences. Participants also spoke to SNI doctoral students about their posters and attended an SNC talk – which gave them the opportunity to experience the atmosphere of an international scientific conference. To round things off, the students enjoyed laboratory tours, in which they gained insights into the practical work of several working groups associated with the SNI.

The SNI team addressed a wider audience through activities such as those carried out on board a train as part of “MINT on the move” or at the Rüeblimärt in Aarau. Here, SNI staff offered children in particular the chance to complete small craft projects and simple experiments. They also took the opportunity to inform the accompanying parents or grandparents about SNI activities and the nanosciences.

We report on these activities and more on our website and through various social media channels – including via videos. In June and December 2024, the SNI published its online magazine, SNI INSight, providing insights into different research topics and an overview of SNI activities.

Further information:

YouTube channel: https://bit.ly/3u9XLjv

LinkedIn: https://bit.ly/3rbYP4s

Bluesky: https://bsky.app/profile/sniunibas.bsky.social

SNI webpage: www.nanoscience.ch

SNI INSight: https://bit.ly/4jWHcis

Experiments and projects: https://bit.ly/40Uw0Kr

Sixty high-school students took part in the event “TecDay meets Swiss NanoConvention.”

“At the Swiss NanoConvention, we’re learning lots about nanotechnology, which plays a role in a surprisingly large number of areas — there’s still so much to explore.”
Ylenia und Elinor, Cantonal School

On board the train, staff had a great opportunity to help children complete craft projects and experiments and to inform parents about the SNI’s activities.

tunBasel is always a great opportunity to reach numerous children and young people, to help them perform experiments, and to show them how exciting the natural sciences can be.

Financial report

The University of Basel and the Canton of Aargau jointly founded the Swiss Nanoscience Institute (SNI) in 2006. This center of excellence for the nanosciences and nanotechnology – which ensures nanoscience research, knowledge and technology transfer, and excellent education for early career researchers – has long since become an established institution in Northwestern Switzerland. With its strategy for 2024–2034, the SNI has now also laid the ground for a prosperous future. Adhering to this strategy, we will position ourselves in the coming years so that we can put our extraordinary expertise in the nanosciences and nanotechnology to use in addressing the challenges facing society.

Four guiding principles underpin the future of the SNI: focus, collaborate, adapt and impact. The SNI will focus on the core areas of nanoimaging and nanofabrication, in which we will include the full range of activities – from basic and applied research to the service units of the Nano Technology Center (Nano Imaging Lab and Nano Fabrication Lab) and the educational program. Close collaboration by all partners is vital to the success of the interdisciplinary network, as is the continual adaptation of infrastructure to meet ever-increasing technological requirements.

Basis for innovation

At the SNI, the basic research that underpins innovation is supported primarily by funding the two Argovia Professors Rodrick Lim and Martino Poggio, both of whom make significant contributions to the SNI's international reputation with their excellent research. Through their participation in national and international collaborations, the two Argovia professors together received over CHF 1.9 million in funding for their research projects in addition to the funding from the SNI. Besides the Argovia professors, the SNI also supports the work of three titular professors from the Paul Scherrer Institute: Thomas Jung, Michel Kenzelmann and Frithjof Nolting. Together, the professors received funding of some CHF 1.5 million from the SNI budget.

Basic science is the field of research pursued by most doctoral students at the SNI PhD School, which was founded in 2012. The 40 doctoral students who formed part of the PhD School in 2024 work at various institutions within the SNI network but will all earn their doctorates from the Faculty of Science at the University of Basel. In total, the outgoings for the PhD School ran to some CHF 1.9 million. This figure includes salaries of doctoral students, consumables and PhD School events.

Focus on knowledge and technology transfer

The Nano-Argovia program, which has existed since the SNI was founded, is now a well-established platform for supporting knowledge and technology transfer to industry. In 2024, the SNI supported ten Nano-Argovia projects with total funding in excess of CHF 1.4 million. Project partners supplemented this funding with money from public research funding instruments (e.g., Innosuisse, Swiss National Science Foundation, EU funding) as well as a total of over CHF 1.2 million in funding from the participating research institutions themselves. In addition, industrial partners contributed around CHF 1.1 million to the various research projects in the form of in-kind services.

Expansion of Nano Technology Center

Founded in 2022, the Nano Technology Center is made up of two units – the Nano Imaging Lab and the Nano Fabrication

The following table shows the outgoings for 2024 by item of expenditure according to the financial report of the University of Basel of 26 February, 2025:

Expenditure 2024 in CHF		**Univ. Basel**	**Canton AG**	**Total**
Management	Personnel and operational costs	548’185	365’709	913’894
	Overhead		650’000	650’000
Infrastructure	Infrastructure equipment	167’717	469’285	637’002
Know-how and Techtransfer	Personnel and operational costs	27’861	177’590	205’451
	Nano-Argovia projects		1’431’688	1’431’688
Outreach & PR	Personnel and operational costs	81’571	76’436	158’007
Support	Professors Univ. Basel	607’398	770’485	1’377’883
	PSI professors		125’590	125’590
Nano Curriculum	Bachelor and master programs	301’326	237’941	539’267
Nano Technology Center	Nano Imaging/Nano Fabrication	630’580	355’900	986’480
SNI PhD School	Personnel and operational costs	744’911	1’117’367	1’862’278
Total expenditure 2024 in CHF		**3’109’550**	**5’777’990**	**8’887’539**

Lab – and provides customers from industry and academia with comprehensive services in the areas of imaging, analysis, and micro and nanofabrication.

With the strategic focus on nanoimaging and nanofabrication, it is vital for the SNI to establish and maintain modern, competitive infrastructure at the Nano Technology Center's two service units. Thanks to its reserves, the SNI was in a position to continue investing in equipment for the Nano Technology Center in 2024 and to carry out necessary repairs and maintenance work in a timely manner. In total, the Nano Technology Center's budget ran to almost CHF 1 million in 2024.

Studies and public relations

In 2024, there were 76 students enrolled on the bachelor's and master's program in nanosciences at the University of Basel. The SNI contributes over CHF 0.5 million to the program's funding. Over the course of their studies, students receive a broad grounding in the natural sciences and then specialize in subjects that suit their interests, meaning they are ideally equipped to work at the interfaces between different disciplines after they graduate.

The work of the SNI team also includes raising awareness of the degree program as well as informing the general public about nanosciences and the activities of the SNI in general. To this end, SNI staff seek to engage with the public through various formats and use social media to bring them the latest updates from the SNI. Digital channels are also used for communication within the interdisciplinary network. In addition, the SNI team organizes events such as the Annual Event and the NanoTec Apéro, which are vital for ensuring an exchange of ideas within the network. In total, the costs for public relations and internal events came to less than CHF 0.2 million.

Investment in modern infrastructure

Thanks to saved reserves, the SNI was able to invest over CHF 0.6 million in new infrastructure at several research groups and above all at the Nano Technology Center in 2024. In the coming years, the continual expansion of this SNI service unit and the structural support for research groups will continue, reducing the SNI's reserves and helping to bring technical facilities up to a competitive level.

In the SNI's annual financial statement, the last line reports an amount of some CHF 4.9 million as "SNI assets per 31 December 2024, in CHF." This does not take account of orders already made for instruments that will not be delivered until 2025, including infrastructure measures at the Nano Technology Center and at research groups to a value of around three quarters of a million francs. There is also a proportion of funding for Nano-Argovia projects that has not been spent yet. A significant part of this funding consists of reserves for ongoing doctoral dissertation projects, as doctoral students at the SNI PhD School take up their position over the course of the year and are always funded for a period of 48 months.

Many thanks

We would like to extend our sincere thanks to the Finances department of the University of Basel for its excellent collaboration over the last year and for its efficient financial reporting. Huge thanks also goes to the Cantons of Aargau, Basel-Stadt and Baselland, whose ongoing commitment makes it possible for the SNI to train outstanding early career researchers, gain new scientific insights, and support companies with innovative projects as we work toward building a better future.

The following table shows the income statement of SNI funds as of 31 December, 2024:

SNI annual statement 2024 in CHF

	Univ. Basel	**Canton AG**	**Total**
Grants	2'766'439	5'247'940	8'014'379
Investment income	18'947	151'625	170'571
Income	**2'785'385**	**5'399'565**	**8'184'950**
Expenditure	**3'109'549**	**5'777'990**	**8'887'539**
Annual balance 2024	**(324'164)**	**(378'425)**	**(702'589)**
SNI assets per 01/01/2024	**1'989'547**	**3'577'167**	**5'566'715**
Annual balance	(324'164)	(378'425)	(702'589)
SNI assets per 31/12/2024 in CHF	**1'665'383**	**3'198'742**	**4'864'125**

Organization

Argovia Board
Regierungsrat A. Hürzeler, Head Department of Education, Culture and Sport, Canton of Aargau
Prof. Dr. A. Schenker-Wicki, President University of Basel
Prof. Dr. M. Poggio, Director SNI
Prof. Dr. C. Bergamaschi, President FHNW
Prof. Dr. G.-L. Bona, former Director Empa
Dr. W. Riess, former IBM Department Head & Coordinator Binnig & Rohrer Nanotechnology Center
Prof. Dr. C. Rüegg, Director Paul Scherrer Institute

SNI Executive Committee
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Prof. Dr. P. Maletinsky, Vice Director (Nano-Argovia program)
Prof. Dr. S. Hiller (Biozentrum, Dean Phil. Nat.)
Prof. Dr. J. Huwyler (Curriculum Nanoscience, Department of Pharmaceutical Sciences)
Prof. Dr. R. Y. H. Lim (Biozentrum)
Prof. Dr. K. Moselund (Paul Scherrer Institute)
Prof. Dr. O. Tagit (University of Applied Sciences Northwestern Switzerland)
Prof. Dr. O. Wenger (Department of Chemistry)
C. Wirth, General Manager SNI
Prof. Dr. I. Zardo (Nano Technology Center and Department of Physics)

SNI Management
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C. Wirth, General Manager
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Dr. K. Beyer-Hans (Outreach, communications)
Dr. A. Car (Curriculum Nanosciences)
Dr. G. Gadea (Nano Fabrication Lab)
S. Hüni (Communications, outreach)
Dr. C. Möller (Communications, media contact, social media)
Dr. B. Utinger (Outreach, communications, since 01.07.2024)
Dr. M. Wegmann (Outreach, communications, until 30.06.2024)
Dr. M. Wyss (Nano Imaging Lab)

Curriculum Nanosciences
Dr. A. Car (Study coordinator)
S. Chambers (Administration)

Nano Imaging Lab
Dr. M. Wyss (Head, TEM, FIB-SEM)
E. Bieler (SEM)
S. Erpel (SEM, TEM)
D. Mathys (FIB-SEM, Image coloring)
Dr. M. Schönenberger (AFM, LSM)
Dr. A. Vogel (TEM, FIB-SEM)

Nano Fabrication Lab
Dr. G. Gadea (Head)
J. Herzog
A. Lücke
X. Wildermuth

Lists of members and projects 2024

Principal Investigators and associated members
https://bit.ly/3QxTTCG

PhD students
https://bit.ly/4ka6vh0

Projects PhD School 2024
https://bit.ly/41uKq5F

Nano-Argovia projects 2024
https://bit.ly/4idlpQA

Further information

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Protein Partnerships
Protein-protein interactions in human thyroid epithelial cells are visualized using an innovative fluorescence technique (BiFC) (green). This approach highlights the precise cellular localization of the interactions and emphasizes the dynamic complexity of protein partnerships in mammalian cells, bridging the gap between nanotechnology and molecular biology. F-actin (red), DNA (blue). (Image: Ahmed H.H.H. Mahmoud, Biozentrum University of Basel)

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Scientific supplement