University of Basel

Swiss Nanoscience Institute

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

SNI INSight

Showcasing research and activities at the Swiss Nanoscience Institute

June 2024

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Editorial

Dear colleagues and nanoenthusiasts,

Many of us met at the Swiss NanoConvention in Basel in early June, where we learned about numerous advances in nanoresearch and had the opportunity not only to refresh old contacts, but also to make new ones. This was the fourth time that the SNI team had organized this interdisciplinary conference with a view to supporting interdisciplinary exchange. All of the speakers, chairs, sponsors and organizers deserve a big thank you – particularly our outreach manager Kerstin Beyer-Hans, who was in charge of organizing and coordinating the event and played a key part in the conference's success. As part of this year's event, I was particularly pleased to invite some 60 pupils to "TecDays meets SNC", where we hopefully provided the next generation of researchers with fascinating insights into the world of the nanosciences.

As we see in our everyday work, those attending the SNC will once again have found that the nanosciences are incredibly diverse. On the one hand, this diversity makes them an exciting and attractive field of study. On the other hand, it also presents certain challenges. It is important that, as a research organization, educational institution and service provider, we avoid spreading ourselves too thinly by trying to engage in every area. Rather, we need to focus on certain core areas of the nanosciences – because this is the only way to achieve and maintain excellent standards.

In various committees over the last year, we've discussed what this focus should look like in detail and what other guiding principles we should strive for as we look to the future of the SNI, and we've set these aims out in a strategy paper geared toward the next 10 years. This process began over a year ago with preparations in the management team and a workshop attended by both internal and external colleagues, who gave their recommendations. After further discussions, we compiled a document that has been approved by the Executive Committee and the Argovia Committee and that will now serve as a roadmap for the coming years.

Now, it is time for the real work to begin – and it is up to all of us to put theory into practice. Specifically, this means focusing on the key areas of nanoimaging and nanofabrication in the fields of materials science, quantum science, life science, medicine and the environment, as well as bolstering and expanding collaboration within the network, adapting our programs and equipment to changing circumstances and, ultimately, ensuring that our activities are a source of inspiration for the general public.

The Nano-Argovia program is an excellent example of how we're already well on the way to implementing this strategy. In this edition of *SNI INSight*, we present five new projects that were launched at the start of this year, all of which feature collaboration across different disciplines and institutional boundaries.

The description of the applied Nano-Argovia projects helps to ensure that members of our network are informed about research activities of associated research groups. To further encourage interdisciplinary exchange, there is a new section of *SNI INSight* in which we report on grants received by SNI members – even if they don't come from the SNI. Please tell us about any relevant news so that we can relay this information as fully as possible.

Of course, there are always people behind the research we present – and we report on some of these individuals in this edition of *SNI INSight*. For example, Aris Lafranca from my team is receiving this year's prize for the best master's thesis in nanosciences, and in the guest article, Michelle Arnet reports on her time at the University of Cambridge, where she completed her master's thesis thanks to an Argovia Travel Grant.

In this issue, we'd also like to say a heartfelt thank you to our outreach manager Michèle Wegmann, who has been a committed member of the SNI management team over the last eight years. Michèle is leaving the SNI and, from this summer, will work as an elementary school teacher in her local area. We wish her all the best as she takes on this new challenge and would like to welcome her successor, the nanoscientist Battist Utinger, to the SNI team.

With that, I hope you enjoy reading *SNI INSight* and I look forward to hearing your feedback.

Kind regards,

Prof. Martino Poggio, SNI director

SNI Strategy
Aims and measures for the next ten years

In its Strategy 2024–2034, the Swiss Nanoscience Institute (SNI) provides a road-map for its targeted development over the next ten years. The ultimate aim is to position the SNI such that it can put its extraordinary expertise in nanoscience and nanotechnology to use in addressing the challenges facing society. We aim to be a lighthouse for research, education and innovation in nanoscience and this strategy paper serves as a guide for members of the interdisciplinary network, the University of Basel, political decision-makers and the general public to reach this goal.

Four guiding principles
The SNI's four guiding principles for the future are to focus, collaborate, adapt and impact.

Focus

Over the next decade, the SNI will focus on the core areas of nanoimaging and nanofabrication. The SNI's predecessor institution and the SNI itself were founded by scientific pioneers, who were among the first to visualize and manipulate structures at the nanoscale. Building on this tradition of excellence, we aim to consolidate and expand our expertise in these areas. This will help us to address challenges in the fields of materials science, quantum science, life science, medicine and the environment. As part of these efforts, we will involve all parts of the SNI, including fundamental and applied research, our service units (Nano Imaging and Nano Fabrication Lab), and our educational program.

Collaborate

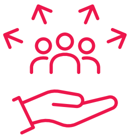
Close collaboration is crucial for the success of an interdisciplinary network like the SNI. Thanks to the SNI's established structure, researchers from different disciplines and institutions work together on basic and applied research questions. The aim for the future is to strengthen identification with the SNI network among its members, to create a stronger sense of "we" and to communicate the SNI's achievements together.

Adapt

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 more and more attractive.

Further information

Strategy 2024-2034
https://nanoscience.unibas.ch/fileadmin/user_upload/nanoscience/04_UEber_Uns/Organisation/Strategy-Paper_en_final_28_5_24.pdf



Impact

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

Relevance in all areas

The four guiding principles are reflected in planned measures affecting all areas relevant to the SNI.

For the network, it is important to further expand the interdisciplinary and interinstitutional community over the coming years. With its shared goals, this community is characterized by excellence in research and identification with the SNI. We will also expand the network's reach by further stimulating exchange with the nanoscience community at the national and international level.

In terms of education, we will focus on training committed young nanoscientists who are ideally equipped to master the complex challenges of the future thanks to their broad knowledge base. The SNI will therefore continually adapt the curriculum of the degree program and step up efforts to get schoolchildren excited about this demanding course of studies. We will make the course and the PhD School more attractive by consolidating the links between education and the SNI's research and service activities. We will strive for closer collaboration with AlumniNano with a view to helping nanoscience students learn about research approaches outside the network and gain a better overview of potential career pathways.

The SNI will concentrate its research and service activities on the areas of nanoimaging and nanofabrication in order to deliver solutions to the challenges facing society. In the future, there will be closer links between the different research groups and the Nano Technology Center (Nano Imaging Lab and Nano Fabrication Lab), which was founded in 2022. The portfolio of customers and partners is to be expanded over the coming years – including through contact with other national and international nanocenters.

Modern equipment for research groups and service units is fundamental in the rapidly changing field of nanosciences and nanotechnology. With this in mind, the SNI will therefore work to ensure that state-of-the-art infrastructure allows research at the highest level.

The SNI team will step up efforts to engage in effective knowledge and technology transfer – after all, it will only be possible to exploit the potential of innovations developed in the research groups of the SNI network (CSEM Allschwil, D-BSSE, FHNW, PSI, ANAXAM, Swiss PIC and the University of Basel) if we succeed in transferring applications of our research findings to companies. The Nano-Argovia program, which has existed since the time of the SNI's founding, will continue to operate in order to promote exchange between researchers from the SNI network and from industrial companies in Northwestern Switzerland as well as jointly developing new products and applications.

In terms of public relations, the SNI is keen to generate a positive association with the terms "nanoscience" and "nanotechnology." The objective is to report on the achievements of SNI researchers in an entertaining manner and to share our fascination with the nanoworld. This involves not only informing the wider public, but also getting children and young people excited about studying a natural science or the nanosciences.

Nano-Argovia program

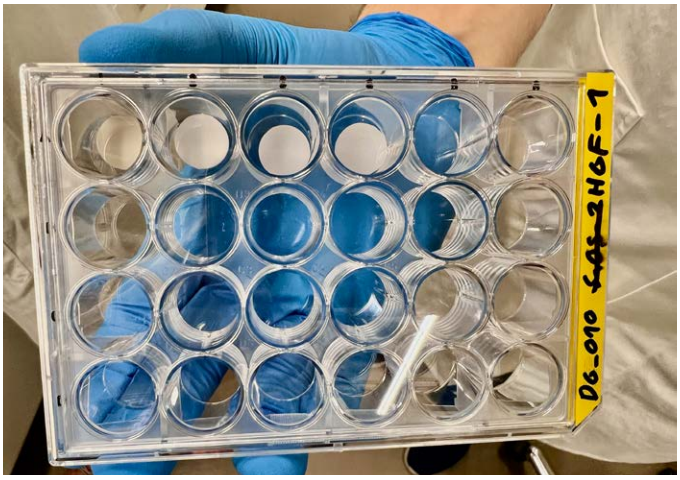
This year, the SNI is supporting 10 applied research projects in collaboration with industrial companies from Northwestern Switzerland. Five of these projects began in January 2024, while the rest have been in progress since 2023. Here, we offer a brief presentation of the new projects.

Toward nanostructured dental implants made of zirconium dioxide

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

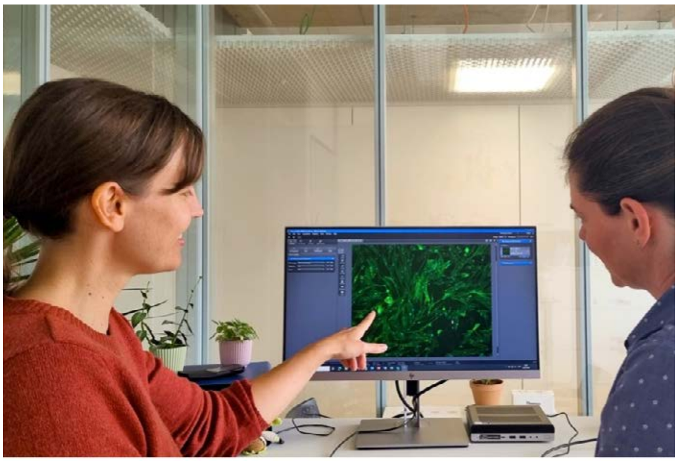
Seeking an alternative

Titanium implants have become the main choice for tooth replacement. As patients increasingly demand more aesthetically pleasing and metal-free solutions, however, researchers are looking for suitable alternatives. The team around project leader Dr. Nadja Rohr (University Center for Dental Medicine Basel UZB, University of Basel) sees great potential in the increased use of zirconium dioxide as a substitute for titanium. The researchers are working with Professor Géraldine Guex (UZB) and the project partners Professor Michael de Wild (IM2, FHNW) and Dr. Raphael Wagner (Institut Straumann AG) to develop the basic principles for further optimizing the surface of zirconium dioxide implants.



The team working on the Nano-Argovia project ZIRYT uses various zirconium dioxide disks to study the interaction with different cell cultures.

Currently, the surface of the implant section anchored in the jaw is sandblasted and etched with acids in a complex process to create a suitable surface microstructure that supports the ingrowth of bone cells. In the Nano-Argovia project ZIRYT, researchers are now working to produce a nanostructured surface using only targeted heat treatment. This is possible because, under the influence of heat, zirconium dioxide forms crystals on the surface that create the nanostructure.



Nadja Rohr and Géraldine Guex examine the growth of various cell cultures on zirconium dioxide samples.

Nanostructure with ideal properties

The Nano-Argovia project ZIRYT aims to determine how the nanostructuring of the zirconium dioxide surface affects the integration of bone tissue *in vitro*. The researchers are investigating the influence of different starting materials and heat treatment processes on the crystal structure and therefore on surface topography. Using state-of-the-art analytical methods and different cell culture models, the researchers evaluate the interaction between implant material and tissue.

In this way, they will determine the ideal surface structure and define the requirements for manufacturing. The project will help facilitate the production of next-generation zirconium dioxide dental implants for the benefit of patients.

Collaboration between:
University Center for Dental Medicine Basel UZB of the University of Basel // IM2, FHNW School of Life Sciences // Institut Straumann AG (Basel)

Géraldine Guex discusses how the experiments are performed with master's student Daniel Gauss.

Further information

Nano-Argovia program
https://nanoscience.unibas.ch/en/forschung/applied-research/

UZB
https://www.uzb.ch

FHNW School of Life Sciences
https://www.fhnw.ch/en/research-and-services/lifesciences

Straumann
https://www.straumann.com/en/dental-professionals.html

"We believe that zirconium dioxide-based dental implants will grow to become a significant market in the coming years. For this reason, we're particularly interested in the results of the ZIRYT project, which has the potential to optimize both the complexity of the manufacturing process and the clinical results of our products – for the benefit of patients. Our long-standing and successful collaboration with the UZB, the University of Basel and the FHNW encourages us to continue supporting these centers of competence in their excellent research."

Dr. Raphael Wagner, Institut Straumann AG (Basel)

Nano-Argovia program
Submit your project proposals

In the Nano-Argovia program, the SNI promotes applied nanotechnology research projects. Companies from Northwestern Switzerland work together with partners from at least two different academic institutions.

Submit your project proposals by September 30, 2024.

Information about the Nano-Argovia program and proposal requirements can be found at:
www.nano-argovia.swiss

For an overview about the Nano-Argovia program, we've put together a new flyer that offers an overview of the Nano-Argovia program.
https://bit.ly/3KoqurE

Protein nanocrystals – Structural determination of proteins at atomic-level resolution using electron diffraction

The team in the Nano-Argovia project ProtEDinNanoxtals aims to use electron diffraction to investigate the role of hydrogen atoms in protein function, as well as interactions between proteins and ligands. By doing so, the researchers will gain insights into the structure of proteins at the atomic level and a better understanding of vital biological processes, thereby supporting drug development.

Further information

Paul Scherrer Institute PSI
https://www.psi.ch/en

Biozentrum, University of Basel
https://www.biozentrum.unibas.ch

leadXpro
https://leadxpro.com

ELDICO Scientific
https://www.eldico-scientific.com

Hydrogen is always involved

Hydrogen atoms play a decisive role in the structure, stability and function of proteins – the nanomachines that organize the life and shape of our cells. Hydrogen atoms are the lightest but most abundant atoms on our planet. They help to stabilize the three-dimensional shape of proteins by interacting with other atoms – that is, by forming hydrogen bonds – and also participate in the biological function of the proteins themselves. Knowledge of the hydrogen coordinates in the protein structure at the active center is therefore crucial for the development of new active pharmaceutical ingredients, but the limitations of conventional methods mean it is difficult for scientists to map the location of hydrogen atoms in proteins.

Electron diffraction as the method of choice

Now, the interdisciplinary team working on the Nano-Argovia project ProtEDinNanoxtals is planning to use electron diffraction to investigate the position of hydrogen atoms at the active sites of proteins. In this method, accelerated electrons hit the sample and are diffracted due to interactions with atoms inside the thousands of protein molecules that are arranged symmetrically within the nanocrystal lattice. The position of the atoms – and therefore of the molecules – in the sample can be calculated based on the diffraction patterns obtained. Recent years have seen huge progress in the development of electron diffraction measuring devices and sample preparation, paving the way for their use on various proteins.

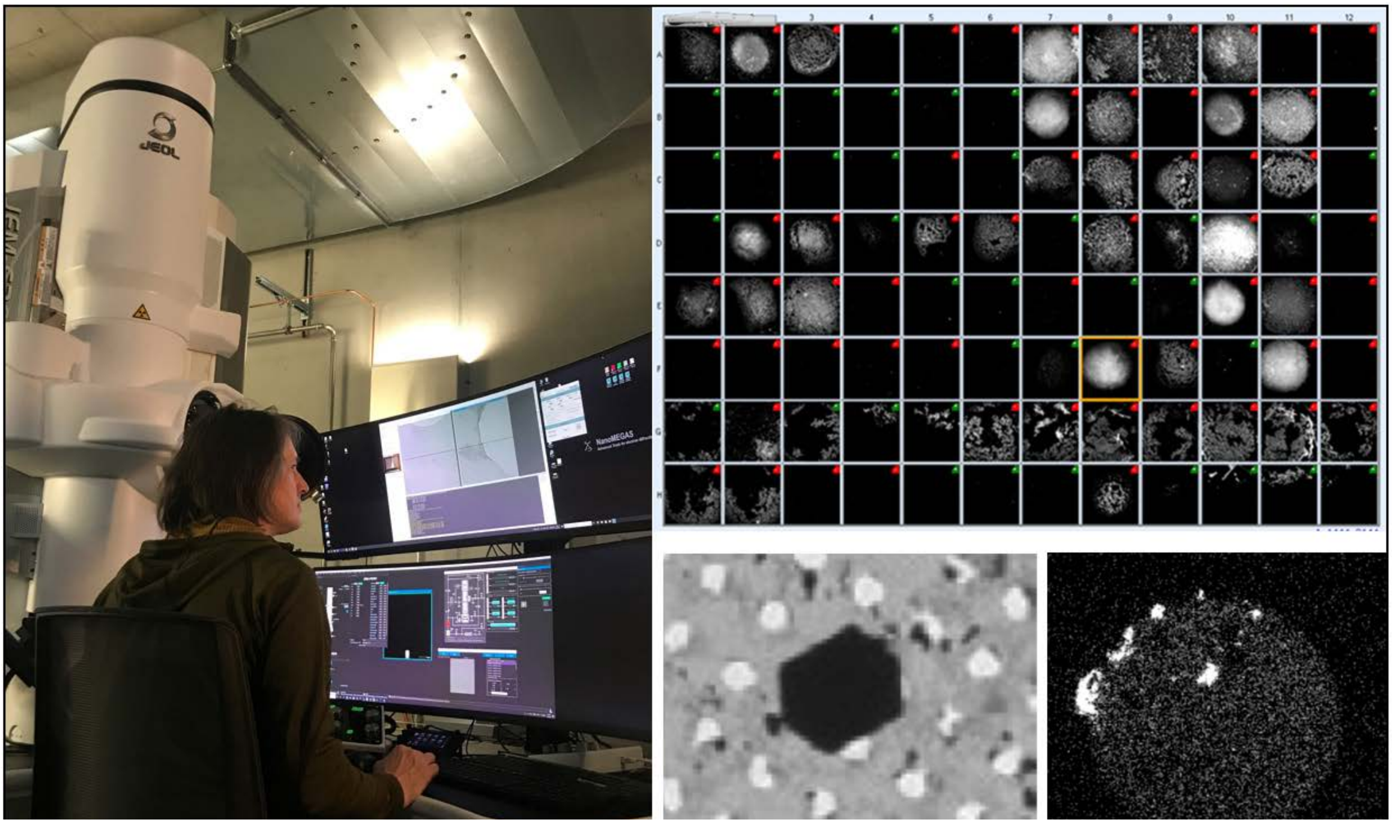
A diverse team of experts led by Dr. Valérie Panneels (Paul Scherrer Institute) will now analyze model proteins of different sizes and functions. These proteins are photosensors that are inactive in the dark and for which the resting structure is known. First, an electron microscope and a horizontal electron diffractometer will be used to measure light-oxygen-voltage-sensing domain 1 (LOV-1), a small domain responsible for the regulation of various functions by light perception in organisms from prokaryotes to

> "leadXpro is specialized in membrane protein structure-based drug discovery with the help of X-ray crystallography and cryo-EM for the discovery of novel medicines. Electron diffraction could evolve as a vital complementary technology for nanocrystals, as well as for the analysis of hydrogen atoms."
>
> **Dr. Michael Hennig, leadXpro**

eukaryotes. In parallel, the researchers will measure and analyze rhodopsin, a larger protein that is responsible for the process of vision. Following these investigations with known model proteins, the team will then examine nanocrystals of further membrane proteins of pharmaceutical interest. The quality of the data will depend on the perfect ordering of the protein crystals, which must be very thin, nanometer-size crystals in order to reduce multiple-scattering events.

With this project, the research team hopes to highlight the advantages of electron diffraction as a complement to other structural biology techniques and therefore to improve the methodology by applying it to membrane proteins in order to gain new insights into the interaction of proteins with their functional ligands. The method allows everything from resolution at an atomic level to information on the hydrogen content, and the project will therefore make a substantial contribution to revealing the mechanisms of action of potential pharmaceutical ingredients. Ultimately, the researchers will add the generated structures to corresponding databases, in which structures obtained by electron diffraction are significantly underrepresented at present.

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



In the Nano-Argovia project ProtEDinNanoxtals, researchers are analyzing how electron diffraction complements other structural biology techniques to gain new insights into the interaction of proteins with their functional ligands. (Image: PSI)

> "ELDICO was the first company to produce commercially available devices that are dedicated to electron diffraction (ED) crystallography. In addition, via its application center in Basel, it constantly refines this method and frequently offers ED as a service to customers in the pharmaceutical industry. In this project, ELDICO will work hand in hand with partners to help expand the potential use of ED on proteins – and especially on challenging membrane proteins."

Dr. Gunther Steinfeld, ELDICO Scientific AG

Enzymes to combat plastic waste

In the Nano-Argovia project NANOdePET, an interdisciplinary team is developing a sustainable method to enable the enzymatic degradation of polyethylene terephthalate (PET) plastic. Using nanotechnology, the researchers working on the project supramolecularly engineer enzymes to equip them with the ability to degrade PET efficiently. The second phase of the project will examine the possibility of implementing the resulting technology on an industrial scale.

Demand for sustainable recycling methods

Worldwide, more than 55 million tons of the plastic polyethylene terephthalate (PET) are produced every year, and this volume will continue to rise in the future. The main applications are packaging (bottles and films) as well as fabrics and textiles. Accordingly, there is an urgent need for innovative measures to prevent a continuous increase in the environmental burden and to enable the reuse of this versatile polymeric material. Today, in industrialized countries, this is primarily achieved by mechanical methods with subsequent melting down and reuse of the material – but this technique produces harmful waste and only allows a limited number of cycles, as the quality of the material decreases with each cycle.

Alternative chemical methods developed so far, which allow processing of the building blocks back into high-quality PET, are not only energy-intensive and costly but also associated with detrimental waste. One solution would involve the enzymatic degradation of PET, but known PET-degrading enzymes are thermally unstable and costly to use.

Amir Nazemi is preparing a protein quantification assay to study the immobilization efficiency and measure the amount of enzyme immobilized on the silica nanoparticles. (Image: FHNW)

Modified enzymes with improved properties

Now, a team of researchers from the FHNW School of Life Sciences and School of Engineering is working with the start-up INOFEA to develop a sustainable PET-degradation method based on enzymatic hydrolysis. The researchers, led by Professor Patrick Shahgaldian, are using a platform developed by INOFEA to modify the nanoenvironment of PET-depolymerizing enzymes (ester hydrolases) so that they exhibit higher stability and a better conversion rate than soluble enzymes.

Using nanotechnological methods, natural enzymes are immobilized on a silica core and stabilized using artificial "chaperones." A coating of organic silica

"This collaboration with FHNW, financially supported by the SNI, offers INOFEA an opportunity to expand its portfolio of nano-engineered enzymes and 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

Further information

FHNW School of Engineering
https://www.fhnw.ch/en/research-and-services/engineering

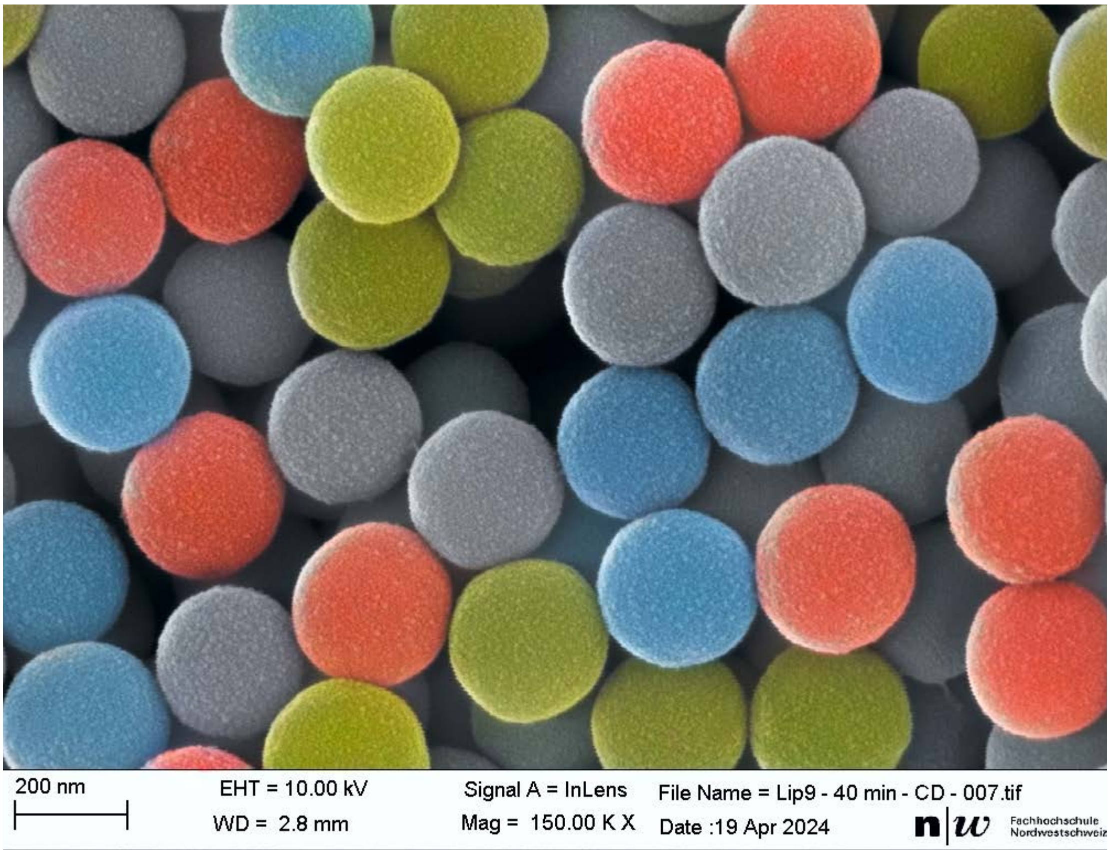
FHNW School of Life Sciences
https://www.fhnw.ch/en/research-and-services/lifesciences

INOFEA
https://www.inofea.com

with a controlled thickness protects the enzymes from external influences but allows the enzymatic degradation of PET.

The researchers will first test suitable enzymes and produce various nanosystems. These systems will then be tested for PET degradation, and a recycling process will be established on a laboratory scale. Next, the team will compare the results with the recycling methods that are currently in use today and evaluate the method's suitability for industrial PET recycling.

Collaboration between:
School of Life Sciences and School of Engineering, FHNW, and INOFEA AG



Immobilized and stabilized natural enzymes are coated with organic silica of controlled thickness. In this way, the enzymes are protected from external influences but are still able to degrade PET. (S.A.Nazemi, FHNW)

Annual Event 2024

The next Annual Event will be held from 4 to 6 September. We look forward to welcoming as many of our members as possible to this year's event at Hotel Seerose at Lake Hallwil.

Video with impressions of the Annual Event 2023.

New detector for better electron microscope images

Researchers working on the Nano-Argovia project HiZfEM are planning to develop a new electron detector with improved image quality for transmission electron microscopy. To this end, the interdisciplinary team of researchers from the Paul Scherrer Institute PSI, the University of Basel and the industrial partner DECTRIS AG (Baden, AG) is applying the experience it has gained from developing other hybrid pixel detectors for photon science.

Further information

Paul Scherrer Institute PSI
https://www.psi.ch/en

Biozentrum, University of Basel
https://www.biozentrum.unibas.ch

DECTRIS
https://www.dectris.com/en/

Improvements are possible

Today, "complementary metal-oxide-semiconductor" (CMOS) detectors are the most popular detector for high-performance transmission electron microscopes. They are based on the semiconductor material silicon and consist of an array of light-sensitive pixels that are integrated on a single chip together with the signal processing circuit. In contrast, hybrid pixel detectors are made up of two separate layers in which the sensor part is separated from the readout part. At present, comparatively thick silicon sensors are also used with hybrid pixel detectors in electron microscopy, but their imaging performance is limited due to multiple scattering in their thicker silicon sensors, which are needed to protect their more sophisticated signal processing circuitry from incident high-energy electrons. The decisive advantage of hybrid pixel detectors over CMOS detectors is the possibility of using sensor materials other than silicon in order to improve the detection capabilities of the detector system. The use of sensor materials with a higher electron density should significantly improve image sharpness, as demonstrated by simulations and recent experimental studies.

Change of detector material

In the Nano-Argovia project HiZfEM, the researchers led by Dr. Dominic Greiffenberg

Researchers working on the Nano-Argovia Project HiZfEM plan to improve image quality in transmission electron microscopy by using new detector modules such as this one made of chromium-doped gallium arsenide (8 x 4 cm²).

from the Paul Scherrer Institute PSI are planning to use gallium arsenide (GaAs) doped with chromium instead of silicon as a detector material in a hybrid pixel detector and to quantify the advantages compared with CMOS detectors in a specific electron energy range.

DECTRIS, one of the world's leading manufacturers of hybrid pixel detectors, is providing the novel sensor material GaAs:Cr for the investigations. The researchers involved are optimistic that, by using the heavier sensor material, they will also be able to improve the quality of data delivered by the transmission electron microscope.

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

"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

On the road to better and safer lithium batteries

In the Nano-Argovia project BatCoat, researchers are investigating a "zero-excess lithium anode" for the next generation of lithium-metal solid-state battery cells, which represent a promising alternative to battery cells based on conventional lithium-ion technology. Li-metal solid-state battery cells have a higher energy density and are safer than the lithium-ion batteries currently used in electric cars, for example. They could therefore make a significant contribution to effective, safe and sustainable electromobility, although there are still some technical limitations that the interdisciplinary team in the Nano-Argovia project BatCoat will seek to address.

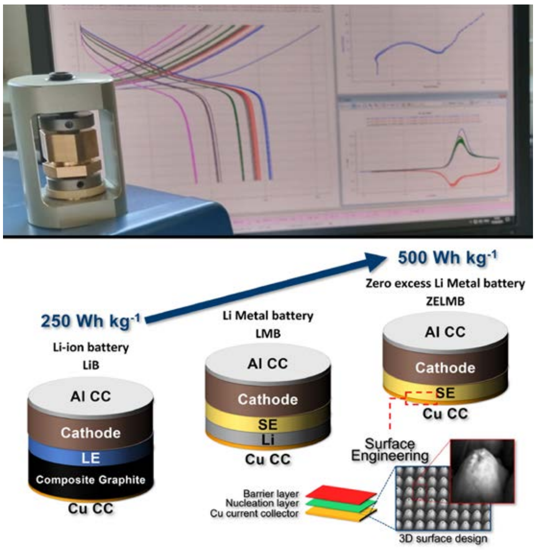
Better safety and stability

In the new Li-metal solid-state battery cells that are being investigated, the negatively charged electrode (anode) is not made of graphite/silicon, as is the case in lithium-ion battery cells, but rather of three-dimensional (3D) copper onto which very thin surface-functional layers are deposited. The nanoscale functional layers help to uniformly and reversibly deposit and strip lithium as the only source in the cathode. Another key difference from lithium-ion batteries is that solid-state battery cells have an electrolyte made of a solid lithium-ion-conducting material. This can lead to better safety and stability.

Before reliable Li-metal solid-state battery cells can become a reality, there are a number of technical hurdles that must be overcome – and this is where the Nano-Argovia project BatCoat comes in. The researchers, led by project leader Dr. Mario El Kazzi from the Paul Scherrer Institute PSI, are investigating how lithium can be homogeneously deposited on a copper surface and withstand more than 500 charge/discharge cycles with sustained high capacity without the lithium reacting with the solid electrolyte. They hope to achieve this by depositing very thin layers of different materials (with a thickness of <100 nanometers) on the copper surface.

In collaboration with Professor Kaspar Löffel from FHNW, the researchers are also investigating the benefits of 3D copper as a promising solution that could help to mitigate the formation of lithium dendrites on the anode, as these can have various negative effects on battery performance and safety. Finally, the researchers will develop a concept for producing these nanoscale functional layers on 3D copper on an industrial scale.

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



The project team uses an all-solid-state cell for accurate and reliable electrochemical testing (top) and roadmaps the evolution of Li-ion battery chemistry, which can be used to boost energy density and improve safety. (Image: PSI)

Further information

Paul Scherrer Institute PSI
https://www.psi.ch/en

FHNW School of Engineering
https://www.fhnw.ch/en/research-and-services/engineering

Oerlikon Metco
https://www.oerlikon.com/metco/en/

> "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

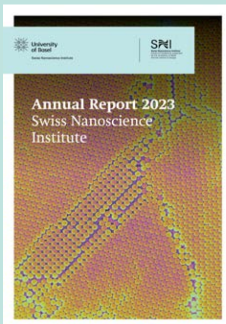
Nano Fabrication Lab flyer

The Nano Fabrication Lab (NF Lab) offers numerous technologies and methods to support researchers with the production of micro and nanofabricated components. We provide an overview of the NF Lab's services in a short flyer.

Nano Fabrication Lab flyer
https://bit.ly/4dYGzln

Annual Report 2023

In the Annual Report, we look back on the year 2023. In addition to short and concise summaries of highlights in different areas of the SNI, a scientific supplement goes into greater depth and describes the results of all projects funded in 2023 over two pages per project.



General part
Animated version with embedded video, print version

Scientific supplement:
Print version

Further information

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

Poggio Lab
https://poggiolab.unibas.ch

Tiny drums as sensors
Aris Lafranca receives the prize for best master's thesis

This year's prize for the best master's thesis in nanosciences at the University of Basel goes to Aris Lafranca. As part of the winning master's 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, the resonator could potentially be used to measure forces, masses or acceleration, as well as for biomedical applications. Aris' investigations sought to better characterize the system, and to monitor and control the influence of temperature.

Combination of positive properties

Aris already began investigating a tiny mechanical hybrid resonator during his first project work in the master's program. These resonators consist of hexagonal flakes of boron nitride (hBN) suspended above holes in a silicon nitride membrane (Si_3N_4) like the skin of a drum. Together, the hexagonal boron nitride and the silicon nitride membrane form a unit that brings together the different properties of these two 2D nanomaterials.

Aris Lafranca completed the work for his award-winning master's thesis in Martino Poggio's team at the Department of Physics.

When the tiny resonator is excited, the boron nitride layer – which is just a few atomic layers thick – begins to vibrate. Due to the special properties of the materials, as well as the resonator's special construction, the resonator can be caused to vibrate not only by mechanical excitation but also by light, for example. Like in a drum, the resonator amplifies the signal such that it could potentially be used as a component in sensor applications.

The researchers "read" the vibrations using light: A laser beam is divided into two beams, one of which strikes the vibrating drum. When the two lasers meet again, they form interference patterns that vary in response to changes in the resonator's vibration.

Decisive improvements

For his master's thesis, Aris investigated and characterized this two-dimensional hybrid resonator further using an improved experimental setup that includes a Michelson interferometer. He was able to extend the setup in order to boost the signal-to-noise ratio and reduce temperature fluctuations. Thanks to these extensions, Aris can now control the sample temperature precisely – which is a fundamental prerequisite for his analyses. He also wrote a Python code that controls sample temperature automatically, and he demonstrated that his measurements show good agreement with theoretical simulations.

Simulations and measurements confirm that the hBN drum has a negative coefficient of thermal expansion. "Contrary to what we know about most other materials, boron nitride contracts in response to a temperature increase," explains Aris. "Since the boron nitride flakes and the silicon nitride membrane form a unit, this contraction leads to increased mechanical stress for the resonator at higher ambient temperatures." This additional stress affects the boron nitride's frequency and mode of vibration, while the frequency and mode of the silicon nitride membrane remain largely unchanged.

As the experimental setup now allows precise temperature regulation, it is possible to configure the mechanical stress inside the hBN drum – allowing researchers to study interactions with the silicon nitride membrane.

Further research on the topic

For Aris, completing his master's thesis is far from the end of his interest in hybrid resonators. Since December 2023, he has continued his work as a doctoral student in the team led by Argovia Professor Martino Poggio. He initially took over the production of the tiny hBN drums, a process that had been developed – and carried out so far – by former SNI doctoral student Dr. David Jaeger as part of his doctoral thesis. In the future, Aris will attempt to couple multiple hBN drums, investigate different thicknesses of hBN membrane and test other samples.

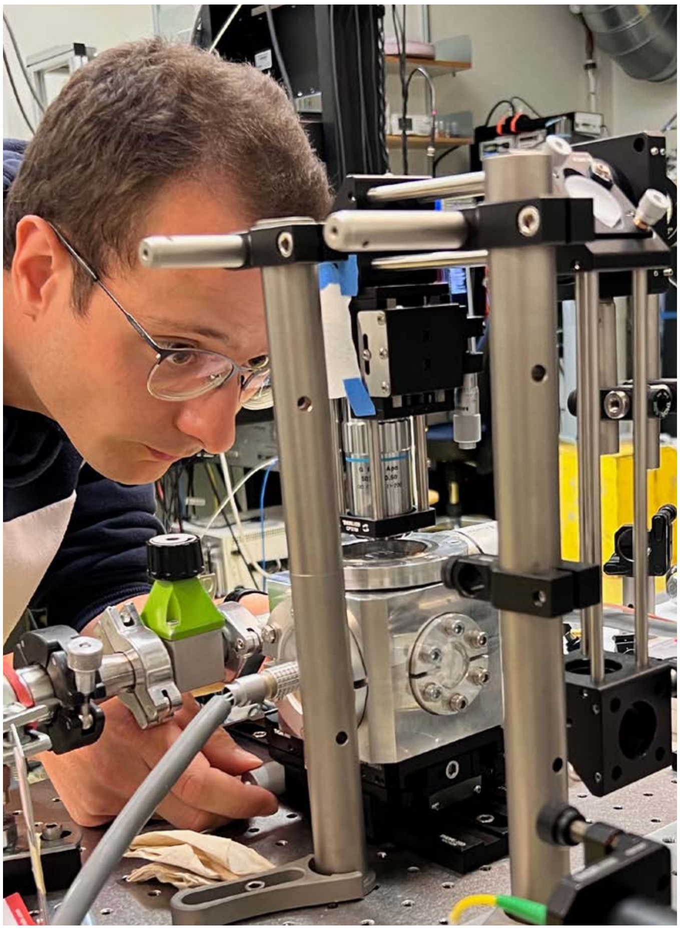
"It's a lot of fun planning experiments of this kind, beginning to take measurements, and then using the results as the basis for solving problems and amending the plan accordingly," says Aris when asked what he finds particularly fascinating about his work. The positive team spirit was another factor in his decision to carry on where he had left off during his master's degree in nanosciences.

An early decision

Aris had already decided to study nanosciences back in his school days, when he learned about the interdisciplinary degree program in nanosciences at the University of Basel during "OrientaTI", a student information event hosted by Università della Svizzera italiana (USI) for cantonal schools in Ticino. "For me, the combination of biology, physics and chemistry was the decisive factor," he recalls.

Things weren't always easy when he started out at Basel – as well as the technical challenges, he also had to get used to the language. "The sense of community among the students helped me a lot, though, and it wasn't long before German was no longer a problem," he says.

As well as the positive atmosphere among students, he particularly enjoyed topics from the worlds of physics and chemistry during his studies – and, with the hybrid resonators, the first project in his master's degree led him to a topic that fascinated him and will keep him busy over the years ahead.



Aris Lafranca uses a Michelson interferometer to investigate and characterize the two-dimensional hybrid resonator.

"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**

Further information

Fruk Lab
https://www.fruk-lab.com

Guest article by Michelle Arnet

Cytochrome c nanoparticles to treat cancer?

Master's project in Cambridge, UK

Thanks to an Argovia Travel Grant, I had the opportunity to do my master's project in the group led by Dr. Ljiljana Fruk (Department of Chemical Engineering and Biotechnology) at the University of Cambridge (UK) – an interdisciplinary molecular and nanoengineering laboratory dedicated to the advancement of green chemistry and biomedical applications.

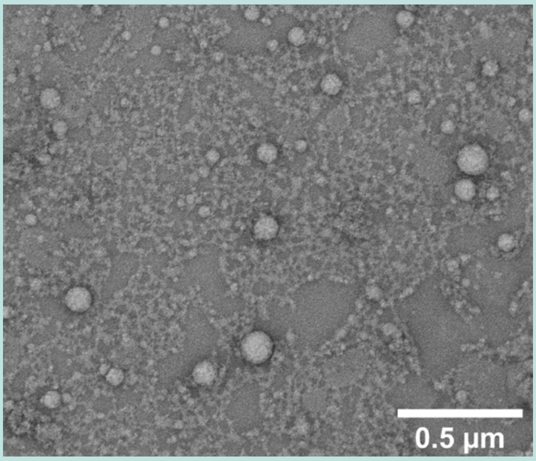
Cytochrome c nanoparticles — potential initiators of cell death

My project required me to work closely with a doctoral student and a postdoc, who together developed an innovative method based on ultrasonic homogenization to produce protein nanoparticles (ProNPs). Their aim was to transport therapeutic proteins to cancerous tissues more efficiently and with low immunogenicity.

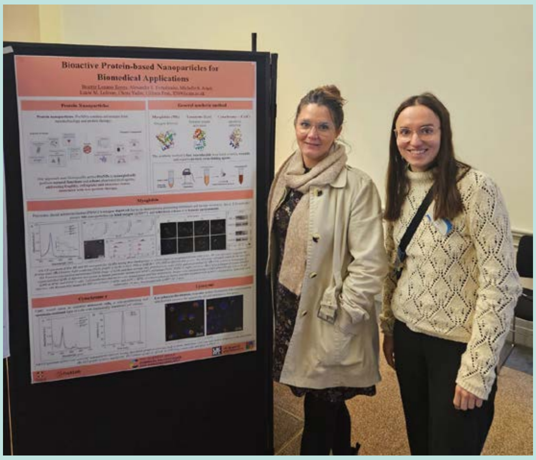
In my project, I developed and characterized specific cytochrome c (cyt c) ProNPs. Cyt c is of interest because it acts as an endogenous mediator of cell death. ProNPs based on cyt c may have the potential to eliminate not only cancer cells but also "senescent" cells – aging cells that can be cancer-inducing if they are located within tumor tissue. Both senescent and cancer cells are resistant to processes that lead to natural cell death, but the natural biological function of cytochrome c could help to overcome this resistance.

Following successful synthesis of cyt c ProNPs, I confirmed their favorable physico-chemical properties using dynamic light scattering, transmission electron microscopy and spectroscopic measurements. I also developed assays to validate the biofunctional activity of the cyt c ProNPs. We then used various cell tests to investigate whether the NPs could induce cell death in cancer cells and senescent cells.

Since the NPs we developed were unable to reach the cytoplasm of the two cell types, they did not bring about cell death, and we were unable to solve this problem despite multiple modification strategies. Nevertheless, the analyses provided us with valuable scientific insights and revealed what steps were needed to exploit the potential of this new class of ProNPs.



Transmission electron microscopy image of cytochrome c nanoparticles produced using ultrasonic homogenization. (Image: M. Arnet)



During my time in Cambridge, I had the opportunity to present our project in the form of a poster at a conference of the Royal Society of Chemistry in London. (Image: M. Arnet)

Extensive new insights and experience

Thanks to this interdisciplinary and multifaceted project, I learned a wide range of new scientific techniques. Furthermore, 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 had the opportunity to present my project in the form of a poster at a scientific conference of the Royal Society of Chemistry in London.

During my time at the Fruk lab in Cambridge, I 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. Being part of the University of Cambridge was an eye-opening and fascinating experience – and, in many ways, it provided me with clarity regarding my future objectives.

As well as spending lots of time in the lab, I took the opportunity to visit various places in England, including Bath, Oxford, the Lake District, Brighton, London and Stonehenge. I enjoyed many evenings in Cambridge and got to experience not just college life, but also British pub culture – complete with "pub grub", beer and quiz nights.

I spent lots of time with the members of my lab, where I made many new friends. (Image: M. Arnet)

Funding of SNI members

Various grants pave the way for innovative lines of research

Numerous SNI members have been awarded grants from various sources in recent months. By providing regular overviews of newly funded research projects, our aim is to keep all researchers in the SNI network informed of the activities of other SNI members. So that we can list the broadest possible selection of awarded grants in SNI INSight, we would be grateful if SNI members could update us regularly.

Forces between molecules

Professor Roderick Lim from the Biozentrum has been awarded a COST project by the European Cooperation in Science and Technology to investigate the forces between molecules in nanopores.

In collaboration with the Nanobiology Institute at Yale University (USA), the Lim team is developing a special high-speed atomic force microscope (HS-AFM) as part of this project. The researchers will then utilize the HS-AFM to determine the nanomechanical forces exerted by specific molecules (phenylalanine-glycine nucleoporins = FG Nups) bound in artificial nanopores. In natural pores in the cell nucleus membrane, FG Nups play an important role in facilitating the transport of large molecules into

Further information

SNSF
https://data.snf.ch/grants/grant/220223

Research group Roderick Lim
https://www.biozentrum.unibas.ch/research/research-groups/research-groups-a-z/overview/unit/research-group-roderick-lim

SNSF
https://data.snf.ch/grants/grant/10000153

Research group Jörg Huwyler
https://pharma.unibas.ch/de/research/research-groups/pharmaceutical-technology-2253/

SNSF
https://data.snf.ch/grants/person/542229

Research group Timm Maier
https://www.biozentrum.unibas.ch/research/research-groups/research-groups-a-z/overview/unit/research-group-timm-maier

and out of the cytoplasm. By resolving the nanomechanical forces in the artificial pores, the researchers also aim to gain a more comprehensive understanding of the impact of these forces in natural nanopores equipped with proteins or polymers on the inside.

Possible treatment for genetic defects

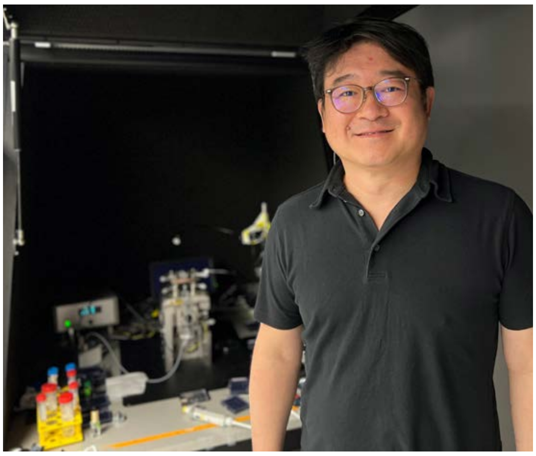
Professor Jörg Huwyler from the Department of Pharmaceutical Sciences has been awarded a Sinergia project together with researchers from EPFL and the University Children's Hospital.

In this project, the researchers want to develop a new generation of stable, long-lasting and safe DNA therapeutics for intravenous administration. Their initial focus is on treatment options for a rare metabolic disorder that is caused by a single genetic defect and primarily affects children.

To this end, the participating teams are planning to develop specific lipid nanoparticles that are loaded with DNA plasmids and bind to specific receptors on liver cells. Based on *in vitro* and *in vivo* experiments, the researchers will test the safety and effect of the developed lipid-based carriers and will use an animal model to analyze whether this approach offers a safe and long-term means of compensating for the studied genetic defect.

Understanding microbial production lines

In a project supported by the Swiss National Science Foundation (SNSF), Professor Timm Maier's group is investigating microbial "factories" in which bacteria and fungi produce polyketides. These highly complex chemical compounds help microorganisms survive



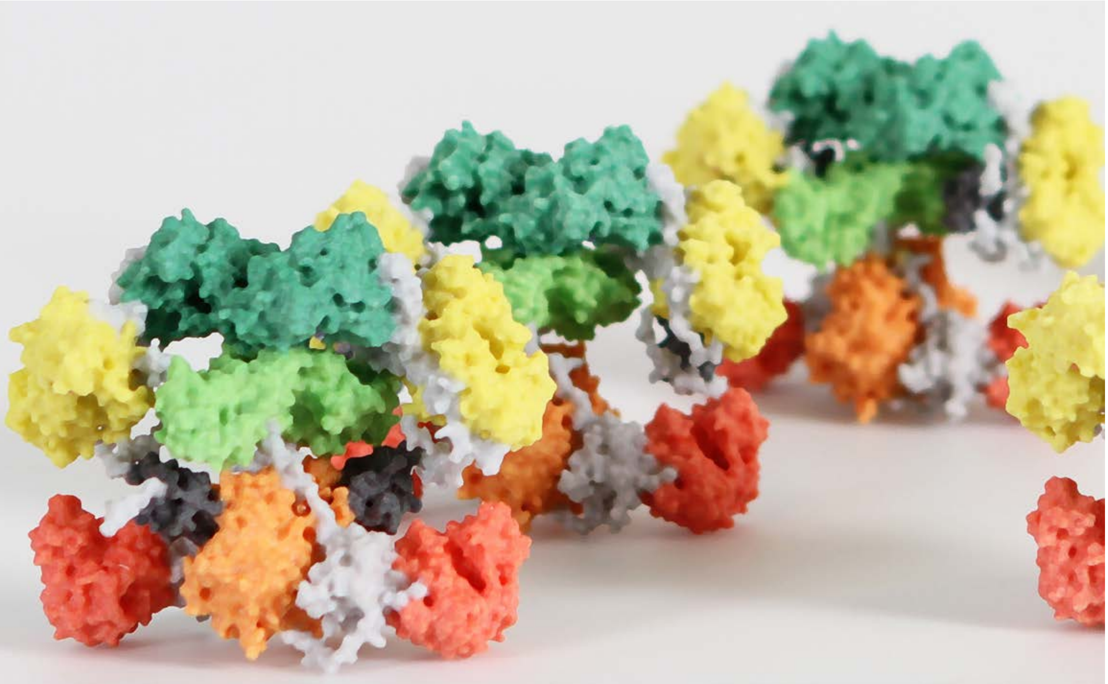
In the approved COST project, Roderick Lim's team is investigating forces between molecules and nanopores using a special high-speed atomic force microscope.

in their natural environment. They have a strong antibiotic effect and are therefore also of interest for the development of new medicines.

The chemical production of polyketides in the laboratory is complex and highly challenging. In microorganisms, on the other hand, it is carried out efficiently in comparatively large production lines with many individual, spatially coupled reaction centers. The researchers from the Maier team now want to use various state-of-the-art microscopes to investigate the spatial structure of the natural "polyketide factories" in the cellular environment with a view to understanding how these factories' unique organization contributes to their functionality.

The expected findings will help researchers to directly optimize or vary the cellular production of polyketides. In gen-

Researchers from Jörg Huwyler's team want to develop stable, long-lasting and safe DNA therapeutics for venous administration in a new Sinergia project. (Image: Adobe Firefly)


A number of different enzymes (polyketide synthases) are responsible for the production of polyketides in the production lines in microorganisms. (Image: T. Maier, Biozentrum, University of Basel)

eral, however, they will also serve to elucidate concepts derived from nature for the development of efficient artificial synthesis systems on the nanometer scale.

New microscope for quantum materials

The research team led by Professor Martino Poggio (Department of Phyiscs, University of Basel)was recently awarded an R'Equip grant by the Swiss National Science Foundation. This grant will be used to develop a novel scanning probe microscope (millikelvin and high-bandwidth scanning SQUID microscope = mK-SPM) operating at temperatures in the millikelvin range. A microscope of this kind is needed to characterize quantum information devices and quantum materials at the low temperatures at which they operate, thereby providing new insights into the development of quantum devices.

The Poggio team will place the new mK-SPM in a dilution cryostat and will be able to cool the microscope down to temperatures of 10 millikelvin (-273.14°C). Furthermore, the researchers will equip the device with the necessary electronics to control qubits and read sensors with a wide bandwidth. The new microscope will be compatible with a variety of sensors, including nano-SQUID magnetometers, multi-gate probes and quantum dot (QD) charge sensors.

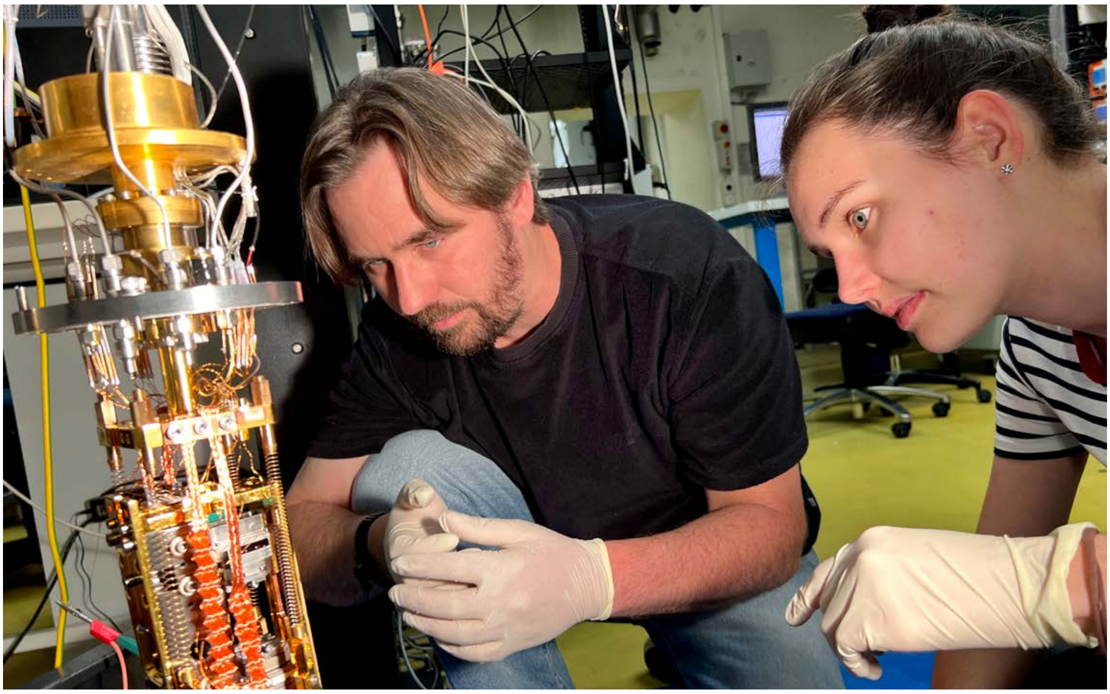
Use for characterization

The Poggio team is also involved in MetSuperQ, a project of the European Association of National Metrology Institutes (EURAMET) that aims to develop a new generation of metrological methods and tools for superconducting qubits and quantum materials. In this project, a consortium of 13 research groups from nine European countries began work in June 2024 with a view to developing the new tools, which will subsequently be applied to superconducting circuits with one or two qubits. These new instruments will enable precise characterization, manipulation and readout of qubits, thereby laying the foundation for further technical progress in quantum technology.

The Poggio lab is primarily engaged in the characterization of qubit components and quantum materials at low and microwave frequencies, as well as in the search for defects in superconducting circuits. To this end, the researchers employ different scanning probe microscopes to analyze qubit components' electrical and magnetic properties. The researchers will initially utilize existing microscopes within a temperature range of 350 millikelvin and will subsequently continue their investigations with the newly developed SQUID scanning probe microscope at lower temperatures of 50 millikelvin – close to the qubits' operating temperatures. The various analyses will assist in the evaluation and improvement of components.

Further information

Research group Martino Poggio
https://poggiolab.unibas.ch



The approved projects support the work of the researchers in Martino Poggio's team. Here, Floris Braakman and Katharina Kress work on a cryostat.

Further information

University of Basel
https://www.pupella.org/post/winners-from-the-propelling-grant-2023-announced-cryo-probe

Research group Richard Warburton
https://nano-photonics.unibas.ch

Publication
https://www.nature.com/articles/s41565-020-00831-x

IDQuantique:
https://www.idquantique.com

Research group Philipp Treutlein
https://atom.physik.unibas.ch/en/

Testing quantum hardware

A Propelling Grant from the University of Basel went to the physicists Professor Richard Warburton and Dr. Andreas Kuhlmann as well as the head of the mechanics workshop, Sascha Martin. The three researchers from the Department of Physics at the University of Basel are working on founding the start-up Cryoprobe.

Their aim is to develop a special cryogenic testing station that will allow rapid and precise testing of solid-state quantum hardware – in particular, semiconductor-based qubits. The testing station will operate at very low temperatures and is to be tailored to the special requirements of quantum hardware.

Source of single photons

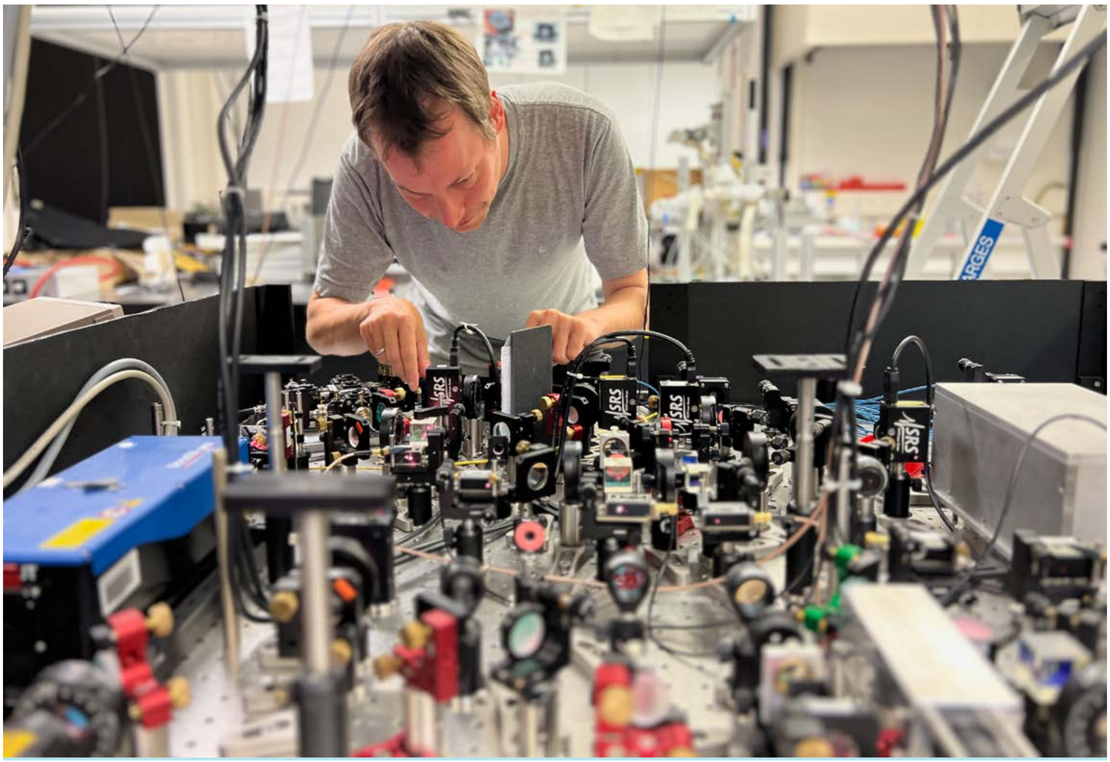
Professor Richard Warburton's group also recently launched the Innosuisse project SparQ. In this three-year project in collaboration with the Swiss company IDQuantique, the researchers aim to develop a user-friendly source of single photons.

Single photons have strong quantum properties and are suitable for various applications in quantum technology – for example, in order to develop secure communication channels (quantum cryptography). Existing single photon sources are based on elaborate, complicated laboratory experiments. With the Innosuisse project, the researchers now want to ensure that, in the future, there will be a user-friendly, simplified and improved means of producing single photons, which will then pave the way for industrial applications.

New measurement method for microwave signals

Since June 2024, the group of Professor Philipp Treutlein (Department of Physics) has been involved in the OnMicro project of the European Association of National Metrology Institutes (EURAMET) with the objective of developing new on-wafer measurement techniques for the characterization of microwave signals on semiconductor chips. The characterization of such chips – which are used in emerging technologies such as 6G telecommunication, autonomous vehicles and wearable electronics – requires more-advanced microwave measurement capabilities.

The Treutlein team will now employ a novel approach utilizing Rydberg atoms as quantum sensors for microwaves in order to achieve enhanced accuracy beyond that which was previously attainable. The Basel researchers are working closely with the Swiss Federal Institute of Metrology (METAS), to which the new technology will be transferred after testing.



Tilman Zibold from the Treutlein team will be working on the EURAMET project OnMicro.

Electron diffractometer from ELDICO Scientific

First delivery to Germany

Further information

ELDICO Scientific
https://www.eldico-scientific.com

The start-up ELDICO Scientific, which was founded in 2019 as part of the SNI network, has delivered and installed its first electron diffractometer in Germany. Based at Park Innovaare, the young company is collaborating with the Max-Planck-Institut (MPI) für Kohlenforschung in Mülheim an der Ruhr. Over the coming months, the researchers in Germany will investigate how ELDICO's electron diffractometer can expand the wide-ranging analytical capabilities of the MPI.

"Research at the Max-Planck-Institut für Kohlenforschung pushes the boundaries of catalysis, including chemical analysis, to provide a deeper understanding of matter. Electron diffraction using the ED-1 is one of the promising techniques when it comes to obtaining structural information for systems that aren't yet fully understood."

Dr. Michael Patzer,
researcher at the Max-Planck-Institut für Kohlenforschung

Rooted in a Nano-Argovia project

ELDICO Scientific is a start-up that emerged from the Nano-Argovia project A3EDPI. As part of the project, an interdisciplinary team of scientists led by Dr. Tim Grüne (then PSI, now University of Vienna) demonstrated that the diffraction patterns of electron beams are excellently suited to elucidating the spatial structure of tiny organic nanocrystals in powder form – while X-rays or synchrotron beams had not led to satisfactory results given the small crystal size.

Based on this positive outcome, ELDICO Scientific has spent the last four years developing the ELDICO ED-1 electron diffractometer, which specializes in precisely this kind of analysis of tiny crystals. One of the first ELDICO ED-1 devices has been available in the "Customer Experience Center" at Innovation Park Basel Area for almost two years. A consortium of four partners supports the platform operated by ELDICO Scientific, in which the SNI acts as an academic partner, opening the door to this promising technology for its members.

> "Taking measurements at ELDICO is a great opportunity to stay at the forefront of crystallography while obtaining results that are impossible with traditional crystallographic methods."

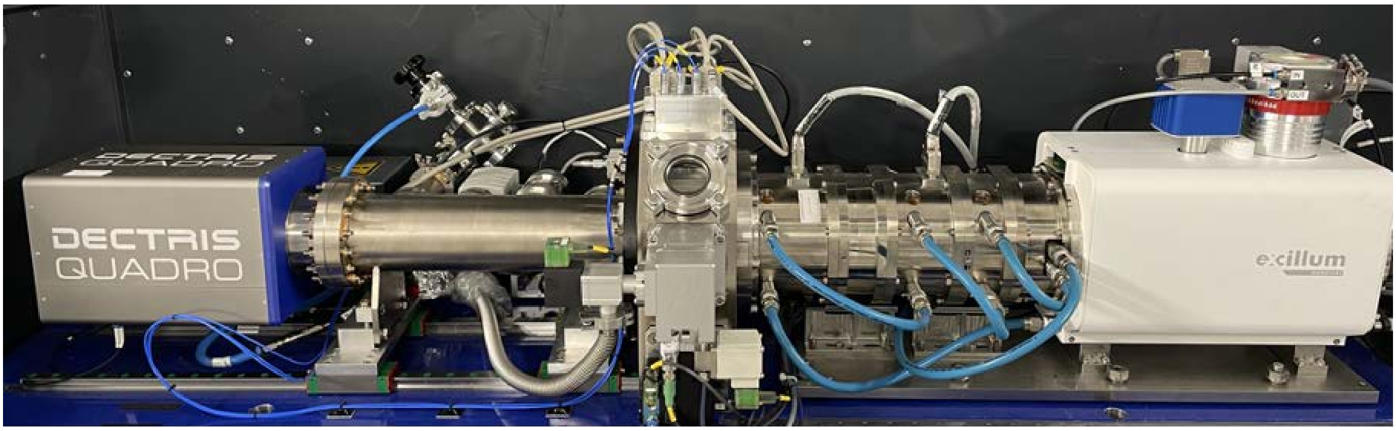
Dr. Alessandro Prescimone, Department of Chemistry, University of Basel

Numerous challenges

Much has happened since ELDICO Scientific was founded in June 2019, with the young company's team evolving alongside advances in device development. Highly qualified new team members – including application scientists and sales staff – have joined ELDICO and are now seeking to bring the electron diffractometer to market and collaborating with wide-ranging customers. In parallel, ELDICO continues to work with its engineering and software development team to improve its devices and make them more user-friendly – and to help shape the future of crystallography as a market leader in the industry. ELDICO will deploy its next instrument for solid-state analysis in the United States, thereby also expanding its market in geographical terms.

> "With the new team, we're ideally positioned to support new customers such as the Max-Planck-Institut für Kohlenforschung, to consolidate our market position, and to drive growth with optimized devices."

Dr. Gustavo Santiso-Quinones, founder and senior scientist at ELDICO Scientific



The inside of the electron diffractometer, ELDICO ED-1, which is now also used by researchers from the Max-Planck-Institut (MPI) für Kohlenforschung in Mülheim an der Ruhr. (Image: ELDICO Scientific)

Awards

In recent months, SNI members have not only been allocated funding from various sources but have also won a series of awards.

For example, Professor Sonja Schmid (Department of Chemistry, University of Basel) received the Young Fluorescence Investigator Award 2024 from the Biological Fluorescence Subgroup at the annual conference of the Biophysical Society in February 2024. This prize is awarded to outstanding young researchers at the start of their careers, in recognition of their work on fluorescence methods.

Sonja Schmid received the Young Fluorescence Investigator Award from the Biophysical Society. (Image: H. Sanabria)

At the March Meeting of the American Physical Society (APS), it was announced that our former director and honorary member Professo Christian Schönenberger (Department of Physics, University of Basel) is to be honored as one of the APS Outstanding Referees for 2024. The Outstanding Referee program was launched in 2008 and recognizes scientists who have been exceptionally helpful in assessing manuscripts for publication in the APS journals. Each year, this highly selective program recognizes some 150 of the around 91,600 active reviewers.

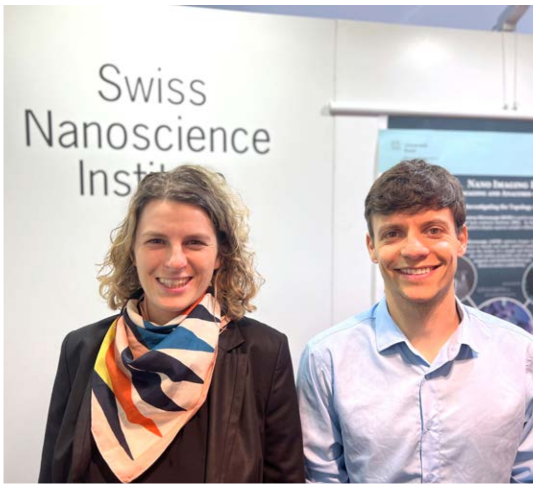
Christian Schönenberger was honored as an APS Outstanding Referee for 2024.

Thank you and farewell to Michèle, and welcome to Battist!

At the end of June, our long-serving outreach manager Dr. Michèle Wegmann is leaving the SNI to focus more closely on children's education as an elementary school teacher.

Michèle has been a key contact for outreach activities with children and for parts of the Annual Report, the Nano-Argovia program and numerous SNI events such as the Annual Event and the NanoTec Apéro. We thank her for her dedication over the last eight years and all of her work to support and advance the interests of the SNI – and we wish her all the best as she takes on this new challenge.

The nanoscientist Dr. Battist Utinger will join the SNI's management team on 1 July. His work will focus on getting pupils and high-school students interested in the nanosciences and informing them about the nanoscience degree with a view to boosting student numbers. Battist will also intensify contact with companies and raise awareness of the SNI's Nano-Argovia program in Northwestern Switzerland, as well as taking over Michèle's tasks in other areas. We welcome him and look forward to working together!



After eight fulfilling years, Michèle Wegmann is leaving the SNI. Battist Utinger will join the SNI management team in July.

Further information

Swiss NanoConvention 2024
https://2024.swissnanoconvention.ch/university-of-basel

Video SNC 2024
https://youtu.be/d2SxVeCabT0

Swiss NanoConvention 2024
Two inspiring days of all things nano

Some 300 participants, 60 high-school pupils, 44 talks, 53 posters, seven awards, 15 exhibition stands and 25 sponsors – these are just some of the figures that define SNC 2024. What the figures don't reflect, however, is the intellectually stimulating yet relaxed atmosphere that provided an opportunity not only to engage in many inspiring conversations but also to forge new contacts and refresh old ones. Over two intensive and interesting days, participants discussed numerous topics and exchanged knowledge regarding innovative nanoresearch and nanotechnology applications.

Openess is the key

The task of organizing the Swiss NanoConvention (SNC) is always not just a privilege but also a challenge, and one that the SNI team is happy to embrace. The SNC is all about nanoscience and nanotechnology in terms of both basic science and applications, and covers areas ranging from quantum science to nanomedicine. This diversity provides a unique opportunity to look outside the box, but also calls for speakers and visitors to open their minds and take an interest in fields other than their own.

SNI Director Professor Martino Poggio touched on this necessity in his welcome address, in which he invited all participants to "challenge themselves to embrace the diversity of topics and attend talks on less-familiar subjects" – for this is precisely the particular attraction of the Swiss NanoConvention. The chair of the Swiss MNT Network, Dr. Michel Despont, used his welcome address to highlight the active participation of industrial companies in the SNC. This offers an ideal platform for exchange and communication between researchers from research institutions and companies.

Contributions by leading scientists

As well as promoting diversity in terms of subject matter and exchange across institutional boundaries, the program and organizing team from the SNI was also keen to invite leading international scientists to the SNC in Basel with a view to offering insights into the latest research findings for the assembled nanocommunity. It is clear from the list of

In his welcome address, SNI Director Martino Poggio invited all participants to embrace the diversity of topics and attend talks on less-familiar subjects – because this is precisely the particular attraction of the Swiss NanoConvention.

"The Canton of Basel-Stadt supports the Swiss NanoConvention because this important exchange of ideas between researchers from different institutions and disciplines paves the way for innovative solutions to wide-ranging challenges."

Dr. Karin Sartorius, Basel-Stadt Congress Board, platinum sponsor

keynote speakers that, this year, the team once again succeeded in this objective.

For example, one of the subjects addressed at the conference were porphyrins. These naturally occurring pigments, which can serve as molecular building blocks of nanowires and nanorings, allow efficient charge transfer over distances of several nanometers (Professor Harry Anderson, University of Oxford). Other topics included tiny acoustic resonators that can be coupled with individual optical photons, making them suitable for numerous applications in the quantum sciences (Professor Simon Gröblacher, TU Delft), as well as "Cooper pair splitters," which can be used to produce and split entangled electrons (Professor Christian Schönenberger, University of Basel).

Professor Kathryn Moler (Stanford University, CA, USA) gave a very clear explanation of what quantum materials actually are and how best to study them as part of the Güntherodt Lecture, which is held at every installment of the SNC in honor of the Basel-based professor of physics and "nanopioneer" Hans-Joachim Güntherodt.

In their keynote lectures, Kathryn Moler and Sébastien Lecommandoux gave exciting insights into their research.

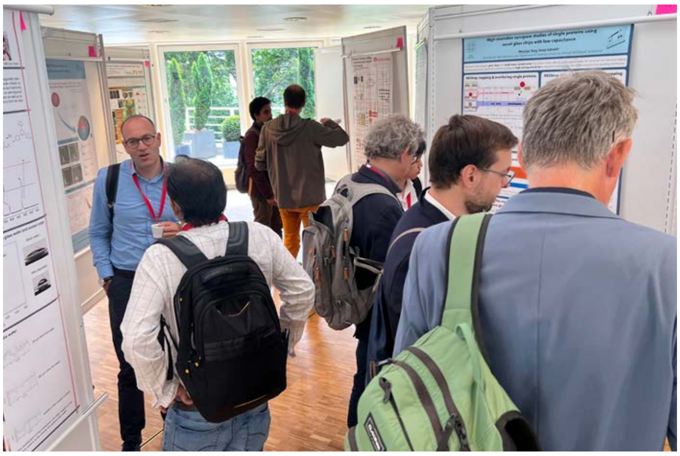
«I enjoyed it greatly and it was wonderful to have the chance to be in touch with the Swiss Nano/Quantum community.»

Prof. Kathryn Moler, Stanford University, CA, USA

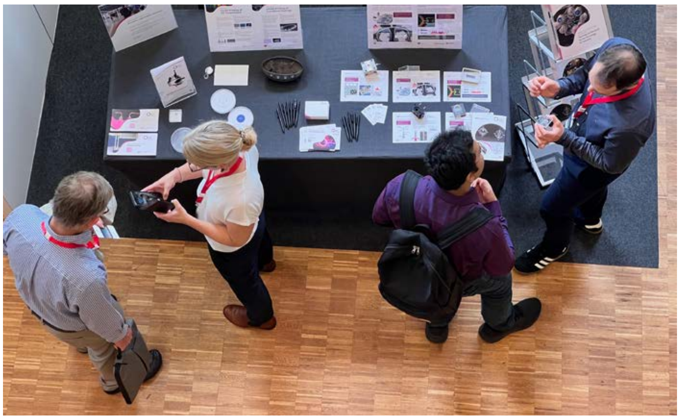
Other keynote talks dealt with self-assembling polymer-based nanovesicles, which can be loaded with active pharmaceutical ingredients, and the preparation of more-complex, compartmentalized artificial cells (Professor Lecommandoux, University of Bordeaux). Key topics in the field of nanomedicine included work on the development of microrobots that can indicate various disease parameters (Professor Simone Schürle-Finke, ETH Zürich), as well as the approach of using liposomes to treat disturbances in the breakdown of ammonia in the human body (Professor Jean-Christophe Leroux, ETH Zürich) – a subject that has already been studied in clinical trials. Dr. Marija Plodinec, CEO and cofounder of ARTIDIS, then explained the challenges scientists face when research is successful and an application is to be established on the market. ARTIDIS is a Basel-based start-up that uses atomic force microscopy to assess the aggressiveness of cancer cells and therefore facilitate better approaches to treatment.

As well as these outstanding keynote lectures, researchers from Switzerland and abroad gave a further 36 talks in parallel sessions. Chairs from the SNI network had ensured that this section of the program also featured a top-class selection of researchers presenting their work – thereby providing the audience with insights into the latest research findings and potential applications. During the breaks, the over 50 posters and 15 exhibition stands provided numerous face-to-face opportunities for participants to find out more, exchange ideas and engage in discussions with researchers.

Interdisciplinary exchange was the main focus of the SNC.(Image: E. Byrne)



Over 50 posters offered an ideal opportunity to find out about different research approaches and to discuss these with the respective researchers during the poster session.



At the exhibition booth, various players from the Swiss nano community provided information about their activities and products.

Insights for pupils

One highlight on the second day of the conference was the visit by 60 school pupils, who gained insights into the world of the nanosciences as part of the event "TecDay meets Swiss NanoConvention." This was organized by the SNI's outreach team in collaboration with SATW and received sign-ups from pupils from all over Switzerland.

Sixty Swiss school pupils visited the SNC as part of "TecDay meets Swiss NanoConvention" and gained an insight into the world of science and nanotechnology.

"We're impressed by the scale of the Swiss NanoConvention, and 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 and Elinor, Schaffhausen Cantonal School

The pupils were first given an introduction to the nanosciences in specially prepared short talks. Next, they looked at various posters to learn about different lines of research from the corresponding doctoral students and attended one of the SNC talks. Lastly, the pupils could also choose between four different laboratory tours – in the Departments of Physics or Chemistry, the University Center for Dental Medicine, or the Nano Imaging Lab of the SNI – in order to get an idea of the everyday practical work of nanoscientists.

Awards for outstanding achievements

At the end of this year's SNC, Professor Christian Schönenberger presented five Swiss Nanotechnology PhD Awards on behalf of the Swiss MNT Network for outstanding first-author publications in the nanosciences by doctoral students from Switzerland in the past year.

This year's awards, which were sponsored by the companies Bühler, Kistler, IBM Research Europe, Nanosurf and nano.swiss, went to Petru P. Albertini (EPFL), Chenglian Zhu (Empa/ETH Zürich), Dr. Samuel Mendes Leitão (EPFL), Marco Coraiola (IBM) and Guanhao Huang (EPFL).

Martino Poggio then awarded the prizes for the best poster presented at the SNC (Aura Maria Moreno Echeverri, AMI) and for the two winning entries for the most beautiful images from the nano and microworld (Daniel Mathys, Marcus Wyss, SNI). After an intensive two days of all things nano, Poggio then bid the participants farewell and extended his thanks to the speakers, chairs, sponsors, exhibitors, student assistants, organizers and participants. He also invited those present to save the date of the next Swiss NanoConvention, which will be held at the FHNW Campus in Brugg on 12-13 June, 2025.

At the end of the SNC, five doctoral students (or a representative in their absence) received the Swiss Nanotechnology PhD Award from the various sponsors. In addition, the prizes for the best poster and the most beautiful picture were announced.

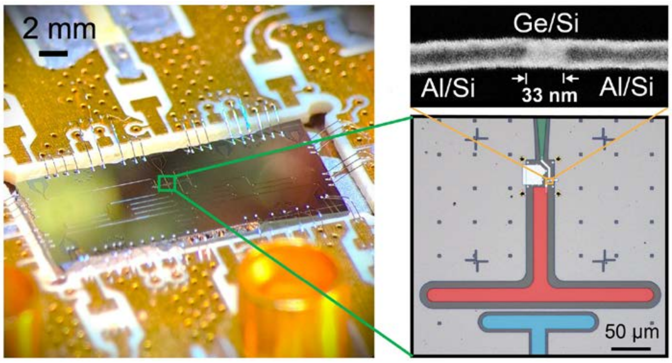
News from the SNI network

Superconducting qubits – voltage tuned

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

SNI post:
https://nanoscience.unibas.ch/en/news/details/mit-spannung-getunte-supraleitende-qubits//

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



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

Methods of generative artificial intelligence can be suitable for quickly calculating phase diagrams of many-body systems. (Image: generated with ChatGPT)

Artificial intelligence calculates phase diagrams

Researchers at the University of Basel have developed a new method for calculating phase diagrams of physical systems that works similarly to ChatGPT. This artificial intelligence could even automate scientific experiments in the future.

University of Basel post:
https://www.unibas.ch/en/News-Events/News/Uni-Research/Artificial-intelligence-calculates-phase-diagrams.html

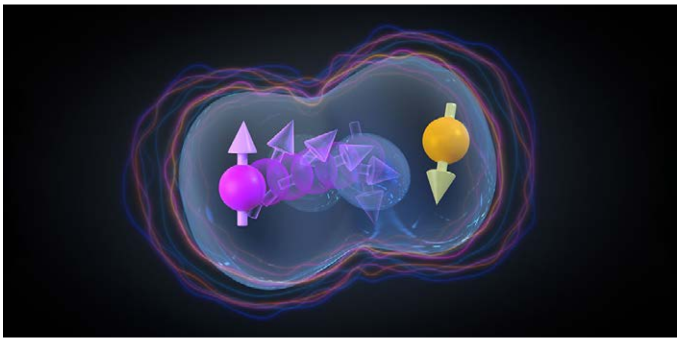
Original publication:
https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.132.207301

Researchers realize a two-qubit gate in a silicon transistor

Researchers from the University of Basel and the NCCR SPIN have achieved the first controllable interaction between two hole spin qubits in a conventional silicon transistor. The breakthrough opens up the possibility of integrating millions of these qubits on a single chip using mature manufacturing processes.

University of Basel post:
https://www.unibas.ch/en/News-Events/News/Uni-Research/Experiment-opens-door-for-millions-of-qubits-on-one-chip.html

Original publication:
https://www.nature.com/articles/s41567-024-02481-5



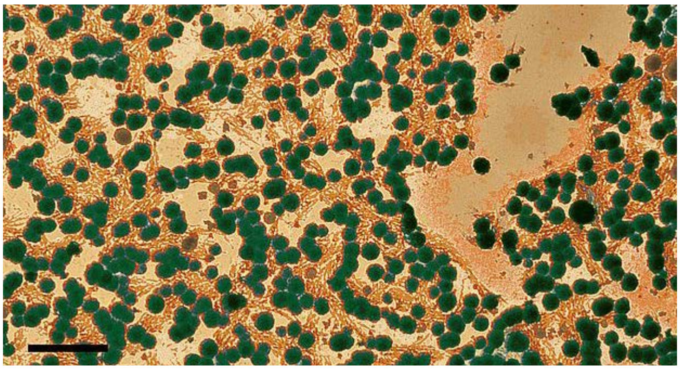
Two interacting hole-spin qubits: As a hole (magenta/yellow) tunnels from one site to the other, its spin rotates due to spin-orbit coupling, leading to anisotropic interactions represented by the surrounding bubbles. (Image: NCCR SPIN)

Method for detecting nanoparticles in early life nutrition

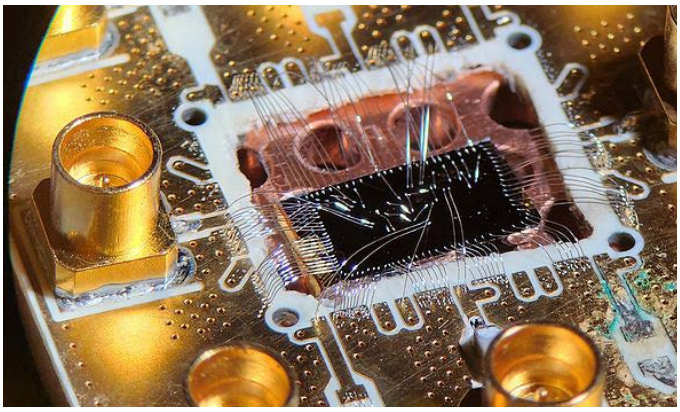
Researchers from the SNI network have developed a technique that can detect nanoparticles (that is, particles with a diameter of less than 100 nanometers) in early life nutrition products with a high sample throughput.

SNI post:
https://nanoscience.unibas.ch/en/news/details/methode-zum-nachweis-von-nanopartikeln-in-lebensmitteln-fuer-kleinkinder/

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



Colorized TEM Image of SiNP (green) in the matrix (orange), scalebar = 400 nm. (Image: S. Saxer, FHNW)



Using a complex experimental setup, researchers from the SNI network have achieved strong coupling between an electron spin and a photon. (Image: A. Pally, 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, an electron spin couples only weakly to photons. To achieve strong coupling with a single photon, the researchers used a special indium arsenide crystal structure. This couples the electron spin naturally to its motional degree of freedom thereby making it open to interaction with a microwave photon.

SNI post:
https://nanoscience.unibas.ch/en/news/details/starke-spin-photonen-kopplung/

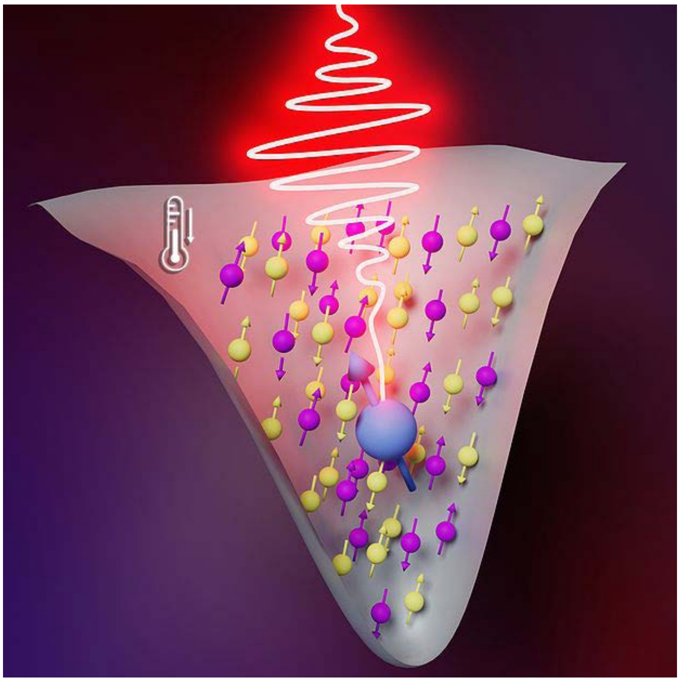
Original publication:
https://www.nature.com/articles/s41467-024-45235-w

Increased coherence thanks to cooling

A team of researchers from the SNI network has increased the coherence of an electron spin in a quantum dot to over half a microsecond for the first time. The scientists achieved the more than 150-fold increase in coherence time by using the electron spin-nuclear spin interaction, which causes the spin system to cool down to 100 microkelvin.

SNI post:
https://nanoscience.unibas.ch/en/news/details/dank-kuehlung-erhoehte-kohaerenz/

Original publication:
https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.131.210805



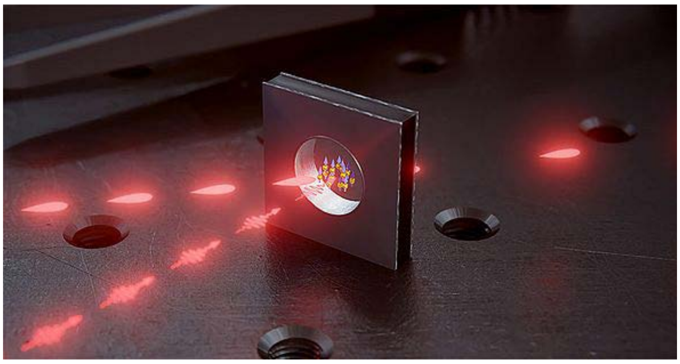
By drastically reducing the fluctuations of the nuclear spins, the coherence time of the electron in the quantum dot can be increased. (Image: Department of Physics, University of Basel)

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, such quantum memories could be mass-produced on a wafer.

University of Basel post:
https://nanoscience.unibas.ch/de/news/details/massenproduzierbarer-mini-quantenspeicher/

Original publication:
https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.131.260801



Light pulses can be stored and retrieved in 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)

Using light to produce medication and plastics more efficiently

Anyone who wants to produce medication, plastics or fertilizer using conventional methods needs heat for chemical reactions – but not so with photochemistry, where light provides the energy. The process to achieve the desired product also often takes fewer intermediate steps. Researchers from the University of Basel are now going one step further and are demonstrating how the energy efficiency of photochemical reactions can be increased tenfold. More sustainable and cost-effective applications are now tantalizingly close.

University of Basel post:
https://www.unibas.ch/en/News-Events/News/Uni-Research/Using-light-to-produce-medication-and-plastics-more-efficiently.html

Original publication:
https://www.nature.com/articles/s41557-024-01482-4

Radicals generated by light can only unfold their reactivity as soon as they break out of a kind of "cage" that the solvent forms around them. Researchers in Basel show how to make this "cage escape" more successful and how it leads to more efficient photochemistry. (Illustration: University of Basel, Jo Richers)

In a two-day workshop, doctoral students at the SNI PhD School learn what is important when it comes to communication.

Communication workshop

Eight doctoral students from the SNI PhD School took part in a workshop on rhetoric and communication in June. Using numerous illustrative examples, science journalist Atlant Bieri showed what is important in communication and how even complex content can be shared clearly and comprehensibly - in a way that everyone will remember.

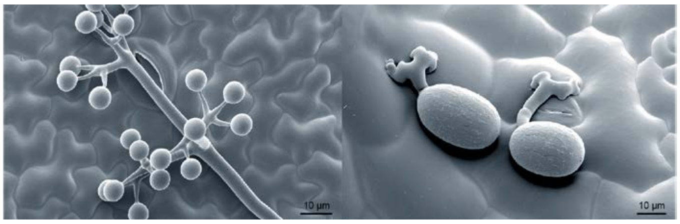
SNI post including short video
https://nanoscience.unibas.ch/en/news/details/rhetorik-workshop-2024/

SmallTalk 2024

On May 15, the "SmallTalk" conference for bachelor's students in nanosciences took place.The students each give a short talk on one of their block courses and present a poster on another block course. They organize the event in advance, put together the program, advertise and moderate the various sessions.

SNI post:
https://nanoscience.unibas.ch/en/news/details/smalltalk-2024/

Every year, the bachelor's students in nanosciences present the results from the block courses as part of "SmallTalk".



Scanning electron micrographs of shock-frozen grapevine leaves infested with downy mildew and powdery mildew. (Image: Nano Imaging Lab, SNI, University of Basel)

SNI post:
https://nanoscience.unibas.ch/en/news/details/widerstandsfaehige-reben-in-zeiten-des-klimawandels/

Resistant vines in times of climate change

The trinational project WiVitis revolves around sustainable viticulture and concepts that help vineyards tackle the challenges of climate change. Switching over to resistant vine varieties that are adapted to climate change seems an inevitable step. Now, the WiVitis project is collecting data on the stability of the berries' skins as a key factor in grape health at various locations in the Upper Rhine region and in all weather conditions.
Recently, the project partners from Germany, France and Switzerland got together for a project meeting in order to consolidate strategies for data collection, discuss experimental setups and agree on protocols for the 2024 season.

The Nano Imaging Lab User Event was a great opportunity to hear from other research groups, learn more about the diverse capabilities of the Nano Imaging Lab and witness the honoring of the Nano Imaging Lab's two thousandth customer.

Diverse examples of projects in the Nano Imaging Lab

The Nano Imaging Lab user event took place in April. In short presentations, six researchers described their research approaches and how they are supported by the Nano Imaging Lab team. The range of research topics reflected the wealth of tasks that the NI Lab deals with on a daily basis.

SNI post:
https://nanoscience.unibas.ch/de/news/details/vielfaeltige-beispiele-von-projekten-im-nano-imaging-lab/

SNI INSight — Showcasing research and activities of the Swiss Nanoscience Institute

Concept, text and layout: C. Möller, M. Poggio
Translations and proof-reading: UNIWORKS (Erlangen, Germany)
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