



University
of Basel

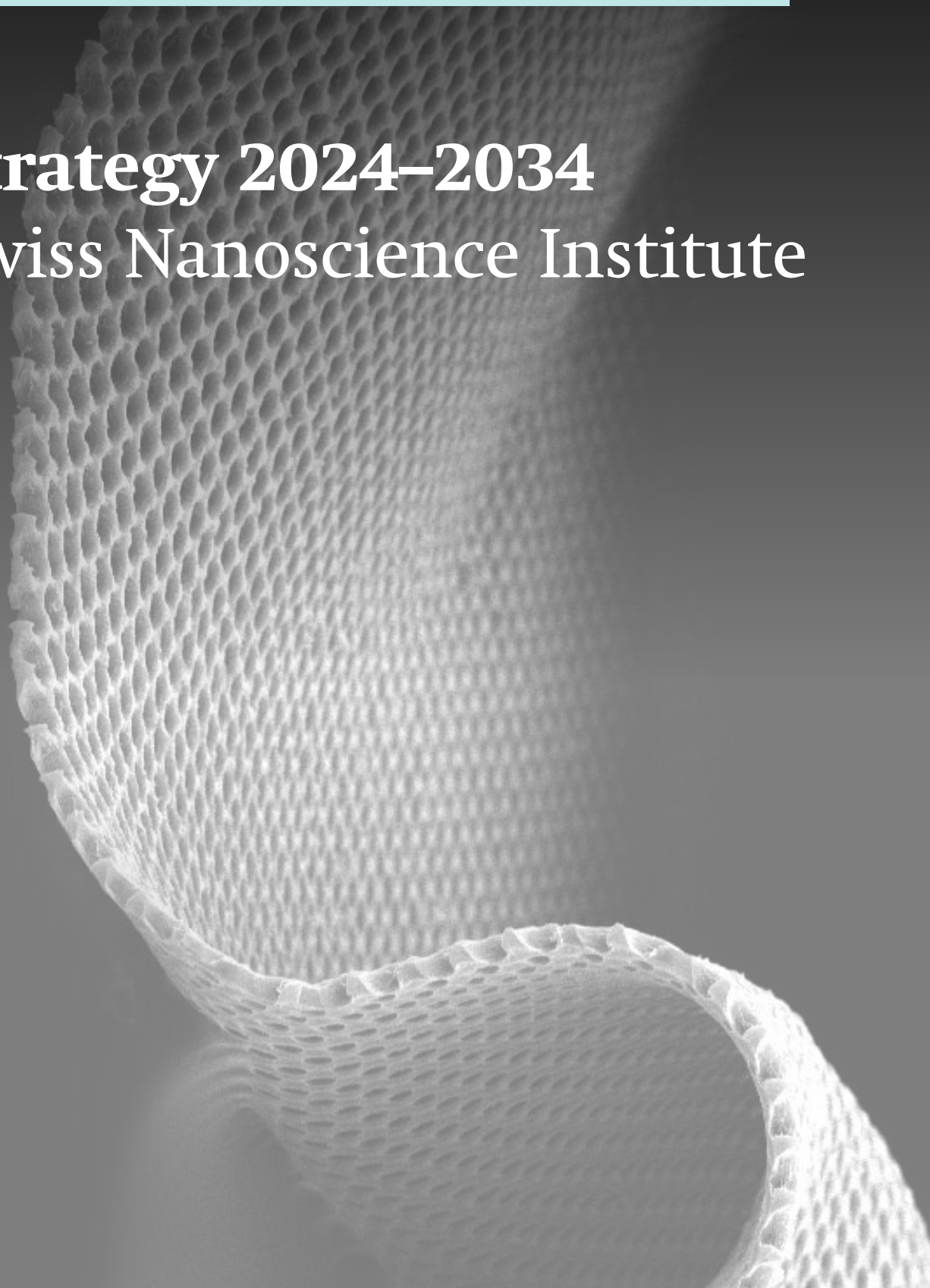
Swiss Nanoscience Institute



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

Strategy 2024–2034

Swiss Nanoscience Institute



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Executive summary

In its Strategy 2024-2034, the Swiss Nanoscience Institute (SNI) provides a roadmap for its targeted development over the next 10 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.

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

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.

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.

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.

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.

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

The Swiss Nanoscience Institute – regionally anchored, internationally successful

The Swiss Nanoscience Institute (SNI) is a center of excellence for nanoscience and nanotechnology founded in 2006 as the successor organization of the National Center of Competence in Research (NCCR) “Nanoscale Science”. It was established on the initiative of the Canton of Aargau and the University of Basel to promote education, research, and knowledge and technology transfer in nanoscience and nanotechnology in Northwestern Switzerland.

In the next 10 years, we aim to be recognized as one of the top centers for nanoscience in Europe. Switzerland has a tradition of precision manufacturing rooted in centuries of cultural heritage, coupled with a propensity toward innovation and a strong educational foundation. As watchmaking has given way to micro and nanoengineering, Switzerland needs a lighthouse for research, education and innovation in nanoscience to remain a global leader in precision and high-quality manufacturing. Our aim is to position the SNI, exploiting its established expertise, reputation and potential, as just such a lighthouse. This Strategy 2024–2034 serves as a guide for the targeted development – for political decision-makers, the University of Basel, employees and members of the interdisciplinary network. The document also provides the general public with a clear picture of the SNI’s mission and insight into its future direction.

After a brief description of the Swiss Nanoscience Institute and its history, as well as an explanation of the scientific environment, we address the four overarching strategic directions: to **focus**, to **collaborate**,

to **adapt**, and to **impact**. For each of these, we then present measures that will contribute to the achievement of our goals.

The SNI supports fundamental and applied research projects.

Continuation of interdisciplinary collaborations

In 2001, as part of the NCCR “Nanoscale Science”, researchers throughout Switzerland began to conduct interdisciplinary nanoscience projects across institutional boundaries. Already in the second phase of this twelve-year research program funded by the Swiss National Science Foundation, the value of collaborating across institutions and disciplines became clear. Such cooperation breaks unnecessary barriers

and leads to new insights and new ways of thinking. Stakeholders from around the network were determined to keep the collaboration going after the end of the NCCR.

The University of Basel and the Canton of Aargau therefore joined forces in 2006 to establish a successor organization, the Swiss Nanoscience Institute. The goal was, in addition to education in the field of nanoscience and nanotechnology, to support basic and applied research as well as knowledge and technology transfer to regional industry. The SNI became an important cornerstone in the high-tech strategy later developed by the Canton of Aargau.

Regional network with global outlook

The SNI network includes the University of Basel, the Schools of Life Sciences and Engineering at the University of Applied Sciences and Arts Northwestern Switzerland in Muttentz and Windisch, the Paul Scherrer Institute, 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 recently founded technology transfer centers ANAXAM and Swiss PIC. The SNI also collaborates with the Hightech Zentrum Aargau in Brugg and Basel Area Business & Innovation in the field of knowledge and technology transfer. Despite its regional roots, the SNI has a global outlook. Its researchers are integrated in global collaborations, its members and students come from all over the world and its innovation partners must compete in a global market.

Applied research

With the founding of the SNI, the Nano-Argovia program, financed by SNI funds from the Canton of Aargau, was launched to support collaboration with industry in the region and to boost knowledge and technology transfer between academia and industry.

Each year since then, the SNI, via its Nano-Argovia program, has funded applied research projects in which two different academic partners from the SNI network collaborate with at least one industrial partner from Northwestern Switzerland on a nanotechnology-related project. Up to 2024, more than 100 Nano-Argovia projects have been funded, most

of which have been evaluated as successful by the industrial partners.

Support for professors

Since 2009, the SNI has supported basic research in nanoscience by funding the work of two “Argovia” professors at the University of Basel and their research groups. In the Department of Physics, the current SNI director, Prof. Martino Poggio, and his research group have been conducting research on various topics related to nanomechanics and nanomagnetism. At the Biozentrum, Prof. Roderick Lim has been working on deciphering fundamental principles and functional relationships between molecular mechanics, selectivity and transport in biological systems.

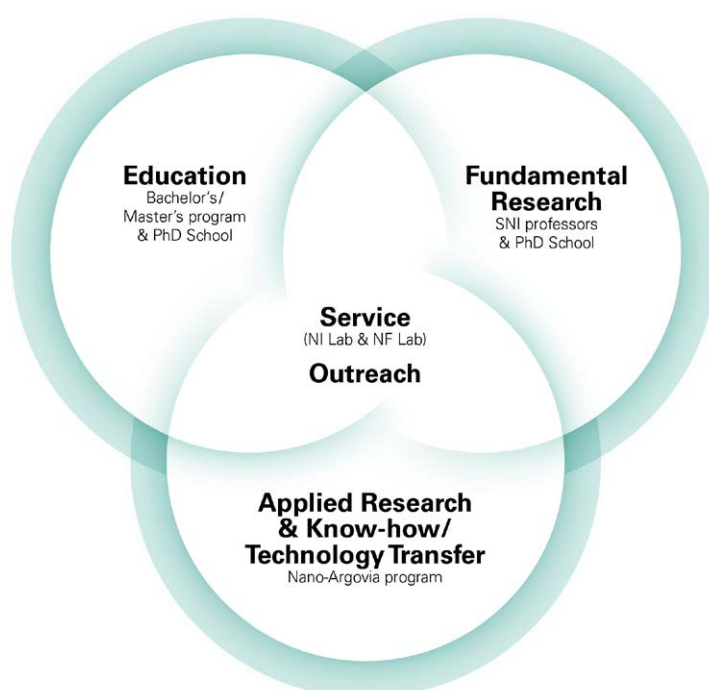
Furthermore, the SNI supports the research of Prof. Patrick Maletinsky, whose research group at the Department of Physics focuses on developing and applying quantum sensors for nanometer-scale imaging and the study of advanced magnetic mate-

rials. Outside of the University of Basel, the SNI supports three adjunct professors: Dr. Thomas Jung, Dr. Michel Kenzelmann and Dr. Frithjof Nolting, who hold teaching positions at the Department of Physics of the University of Basel and are active with their research groups at PSI.

Emphasis on education and training

In 2002, following the start of the NCCR “Nanoscale Science”, the University of Basel established an interdisciplinary study program in nanoscience. From the beginning, the program offered a broad education in biology, chemistry, physics and mathematics in the bachelor’s program – unlike at other universities, which, at the time, limited themselves to establishing a master’s program. In this way, students in Basel first learn the basics in the natural sciences and thus get a solid foundation to later turn to specific subject areas depending on their own interests.

The nanoscience study program offers a broad education in the natural sciences.



The SNI is a center of excellence for nanoscience and nanotechnology. It promotes education, fundamental research as well as applied research, know-how and technology transfer.



The SNI PhD School supports the training of highly qualified scientists.

Another unique aspect of the program in Basel was the inclusion of practical courses (block courses), in which bachelor students already work in various research groups over a period of one to three weeks and thus gain insights into current research projects on very different topics.

In the master's program, students could initially specialize in the fields of physics, chemistry or molecular biology. As the environment we are working in is changing fast, we frequently update our lectures, exercises and practical courses to assure a modern master's program. Therefore in 2022, a fourth specialization, medical nanosciences, was added to the master's program as a further option. In addition to the specialization subject, students in the master's program continue to receive interdisciplinary training.

To further promote the training of highly qualified scientists, the SNI founded the SNI PhD School in 2012. Around 40 doctoral students from around the world are enrolled in this PhD program. Each is supervised by two project leaders from the SNI network – with more than half of the projects having project leaders from different institutions or departments, leading to a highly collaborative and interdisciplinary atmosphere.

Once a year, principal investigators from the SNI network can submit new project proposals. After review by experts from various fields in nanoscience, 6–8 new PhD projects are funded each year. In addition to training doctoral students in their very different subjects, the SNI also supports the young scientists with various courses on rhetoric, innovation, self-discovery or business trends. The SNI attaches great importance to interdisciplinary exchange, in the form of regular events within the network.

The SNI's Nano Technology Center offers excellent services and research support in nanoimaging and nanofabrication.

Services and research support

Starting with the NCCR “Nanoscale Science” and in the early years of the SNI, the network supported the mechanical and electrical workshops of the Department of Physics and was

thus able to provide its network with access to their excellent services.

With the establishment of the Nano Imaging Lab (NI Lab) and its integration into the SNI in 2016, members of the network gained support in the fields of imaging and analysis. The NI Lab, with six highly experienced employees, has established itself as an excellent service unit that is available to clients from both academia and industry. The NI Lab offers a full range of services ranging from introductions to the various high-tech microscopes for self-service to complete service packages, going from sample preparation to finished analysis.

Since 2022, the SNI has expanded its offering with the Nano Fabrication Lab (NF Lab) as a new service unit. In the NF Lab, existing activities and infrastructure from the Department of Physics have been bundled to offer a professional and effective micro- and nanofabrication service. The unit now has four employees, including a nanofabrication manager, who is responsible for the development and maintenance of the facility, as well as for providing professional service to our researchers and external clients.

Together with the NI Lab, the NF Lab was combined to form the Nano Technology Center of the SNI.

Interactive outreach activities

Since its founding, the SNI team has been committed to awakening interest in the natural sciences in the general public and informing different target groups about the various SNI activities.

The SNI seeks direct contact at events such as science festivals, workshops or markets and offers interactive activities. In our experience, face-to-face interactions especially with hands-on demonstrations are the best way to arouse curiosity and to attract interest in the nanosciences. In addition, we offer various programs for school classes, information in the form of brochures and videos, as well as regular updates on various social media channels.

Flat hierarchy, shared tasks

An interdisciplinary management team, under the leadership of the SNI director and the general manager, carry out the SNI's day-to-day business, includ-

ing coordination of the study program and the PhD School, finances, contracts, human resources, administration, running the Nano Imaging and Nano Fabrication Labs, communication and outreach.

The SNI's Executive Committee presides over the institute, meeting several times per year, providing oversight and taking important strategic, financial and scientific decisions concerning the entire network. This committee includes the SNI's director, its general manager and principal investigators from the main participating departments of the University of Basel, the University of Applied Sciences Northwestern Switzerland and the Paul Scherrer Institute.

The Argovia Board, with a total of seven members, is the SNI's governing body with ultimate responsibility for oversight. The Head of the Department of Education, Culture and Sport of the Canton of Aargau chairs the Argovia Board. He or she has voting rights along with the President of the University of Basel, and the SNI Director.

The SNI seeks face-to-face contacts with different target groups and offers interactive activities to arouse curiosity and attract interest in the nanosciences.

Nanotechnology is part of everyday life

The Swiss Nanoscience Institute was founded at the beginning of the millennium in the midst of considerable excitement around the developing field of nanoscience and nanotechnology. Nanoscience was new and nanotechnologies promised innovations in areas as disparate as computer technology and medicine. In the meantime, a large number of innovations that have their origins in nanoscience have been integrated in products and are part of our everyday lives.

In the future, nanoscience will continue to offer new insights and push the boundaries of innovation, leveraging the unique properties of materials at the nanoscale to create new technology. The interdisciplinary nature of nanoscience makes it a fertile ground for innovation. For example, the nanoparticles used for packaging m-RNA in the COVID-19 vaccine emerged at the intersection of pharmaceutical sciences, molecular biology, chemical engineering and immunology. In the ongoing development of the quantum computer, physicists, materials scientists, engineers, and software developers collaborate to realize a scalable and practical platform. Many of the leading platforms, including superconducting qubits, trapped ions or neutral atoms, photonic systems and spin qubits, rely on nanofabrication for their realization. Advances in various other fields including regenerative medicine, energy storage, precision manufacturing and quantum sensing all require similar control of materials on the nanometer-scale. For these reasons, we are poised to experience a decade of significant innovations in nanoscience and nanotechnology, especially in the life science, medicine, energy, environment, computing, materials science and manufacturing.

Although, more than ever, we are surrounded by nanotechnology, “nano” itself is no longer at the tip of everyone’s tongue. Today, when “nano” does appear in the media, it is often related to negative effects – for example, allergic reactions to the nanoparticles in the COVID-19 vaccine.

In an environment in which bad news spreads quickly via social media, there is a danger that a few critical reports on the subject of nanotechnology will reach a far larger audience than positive results that represent genuine innovations. Companies are

therefore often reluctant to name nanotechnology applications as such – which in turn means that positive aspects of nanoscience and nanotechnology are less often in the spotlight.

The general public still has a limited understanding what “nano” actually is, so the need to communicate facts and educate lay people about the real opportunities and risks is great. Therefore, it is important for us to strengthen our outreach activities and to promote ways in which nanoscience and nanotechnology will improve the future.

Dynamic research environment

Advances in nanoscience, unlike in more abstract disciplines, are by their nature close to practical applications and have the potential to impact our everyday lives. In fact, the ways in which nanoscience can address the problems of society via technical advances continue to expand. For example, nanoscience is a fundamental building block for research around quantum technology and promises innovations in materials science, life science, medicine, sustainability and energy supply.

For these reasons, it should not come as a surprise that worldwide in the last 20 to 30 years, renowned interdisciplinary centers for nanoscience have been established, including, for example, the Kavli Institute of Nanoscience at five different locations (Cornell, Oxford, Caltech, Berkeley and Delft). In the early 2000s, the University of Basel, as the Leading House of the National Center of Competence in Research in “Nanoscale Science”, was one of the first institutions to establish both research and education in nanoscience. Even before that, researchers at the University of Basel made a name for themselves worldwide as experts in scanning probe microscopy – and thus contributed to making the nanoworld visible in the first place.

In order to remain at the forefront of international nanoscience research, investments are needed in the infrastructure of the SNI’s research groups and professional service centers, including the Nano Imaging Lab and the Nano Fabrication Lab. The SNI and the existing nanocenters across the world are facing increased costs for the state-of-the-art infrastructure that is required to remain at the cutting

The excellent life sciences environment in Northwestern Switzerland is an important asset.

edge of research.

Since SNI funding comes from the Canton of Aargau and the University of Basel, the network must focus its research, education and technology transfer efforts on Northwestern Switzerland. The region offers a rich diversity of academic and industrial players with a long history of innovation. In addition, the Basel area is one of the world's centers for life sciences. Our partners CSEM Allschwil, D-BSSE, FHNW, PSI, ANAXAM, Swiss PIC and the University of Basel put us in a position to make valuable contributions toward a better future in the fields of nano imaging, characterization of nanomaterials and nanofabrication. Located in the center of Europe at the border of three countries, we are ideally positioned to collaborate with both national and international partners.

For the research groups associated with the SNI, international visibility and excellence is crucial both to work at the cutting edge, but also to attract well-qualified candidates for the SNI's PhD School. In recent years, it has become increasingly difficult to attract excellent young scientists.

Broad range of interdisciplinary courses

In the area of bachelor's and master's degree programs, we also note a stabilization of the student numbers at a level lower than in the early years of the nanoscience program, when the subject benefited from considerable hype in the media. Throughout Switzerland, the University of Basel remains the only university that offers nanoscience as a bachelor's program; however, both nationally and internationally, more and more interdisciplinary bachelor's programs, in such fields as biomedicine or medical engineering, have been established. Young people with a penchant for the natural sciences, who are interested in a variety of subjects, have an increasingly wide range of options to choose from.

In recent years, the SNI has adapted the curriculum of the bachelor's and master's programs in nanoscience to meet the changing landscape. In the future,

the SNI will continue to strive to provide students with a challenging, attractive, application-oriented and interdisciplinary education. In doing so, we want to make clear that nanoscience is crucial for solving society's future challenges, thus making the course attractive to young students committed to making a difference via science.

The excellent life sciences environment in Northwestern Switzerland is an important asset in this regard. In this exciting environment with global companies as well as innovative start-ups, we are able to show students a wide variety of nanotechnology applications in industry right from the beginning of their studies.

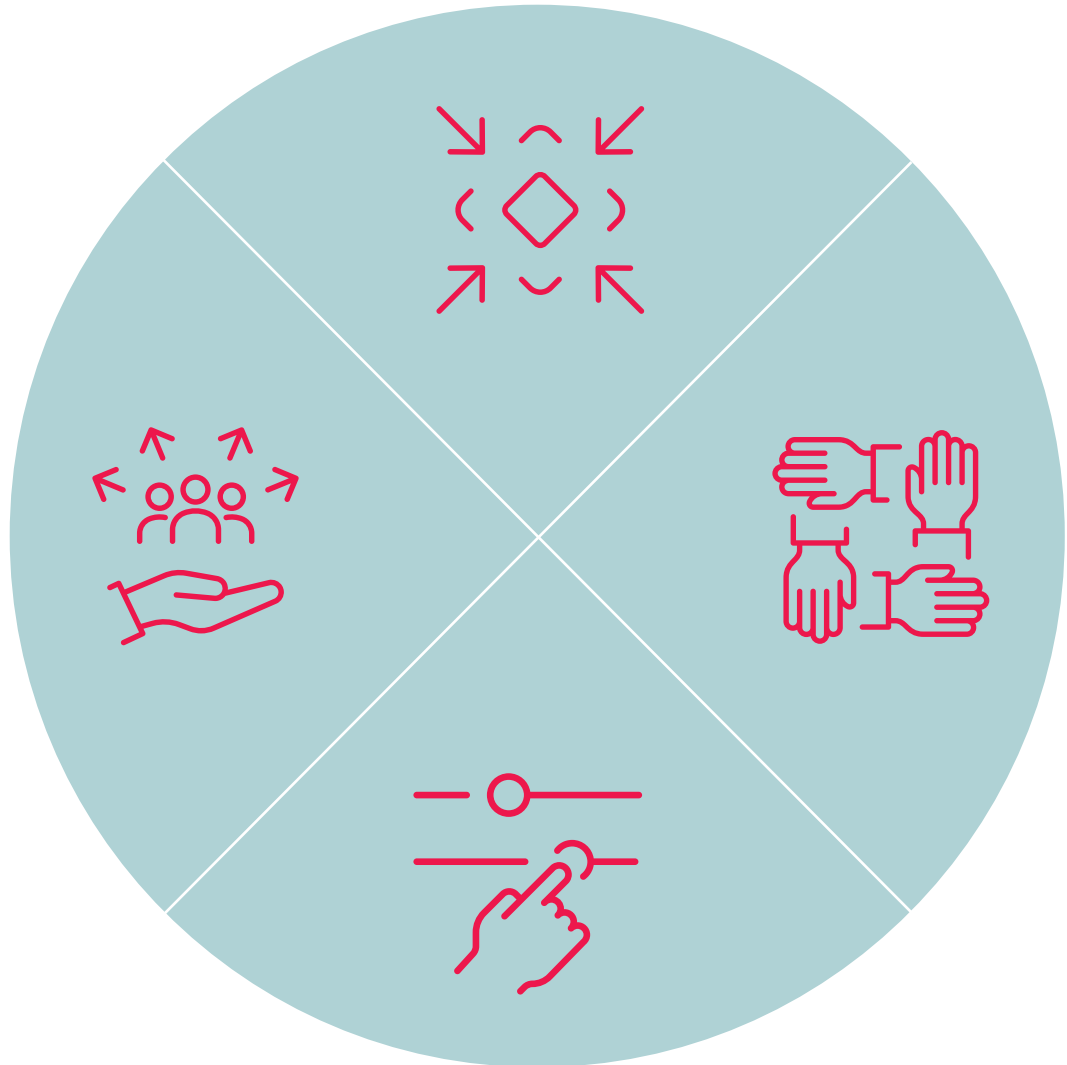
Identification with the network

Since the very start, the SNI's strength has been the diversity of its combined disciplines and expertise, as well as its comprehensive range of areas, from education, to basic and applied research, to research services, to outreach. Its pragmatic administrative structure has minimized administrative overheads and allowed its members to focus on their research and education.

However, it has always been a challenge for the SNI – without its own physical headquarters – to have its members identify with the network and to see it as more than just a source of funding. Growing numbers of motivated members, who join the network not because of project participation but because of their interest in SNI activities, demonstrate the success of ongoing efforts to create a common identity. An SNI building that houses the nanofabrication and nanoimaging facilities, the management team, as well as a center for outreach activities, meeting rooms and working spaces for our nanoscience students would consolidate this identity and promote further exchange. Going forward, this remains an important goal, which would strongly support visibility and identification efforts, as well as ensuring that the SNI has up-to-date infrastructure to compete on the world stage.

It is a challenge for the SNI to achieve an identification of its members with the network.

Vision, mission and strategic principles

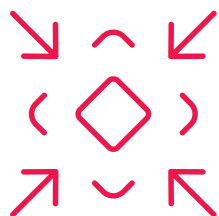


Vision

It is our vision to make life better via nanotechnology. As *the* network for nanoscience in Switzerland, the SNI addresses the challenges of tomorrow through education and research in nanoscience.

Mission

Our mission is to educate excellent young researchers, generate new knowledge, support know-how and technology transfer to industry and to offer services in nanoimaging and nanofabrication. We achieve these goals by leveraging our position as an interdisciplinary research hub for developing nanotechnology and competing with the top nanoscience centers worldwide in research and education.



Focus

In the early 2000s, the University of Basel established itself as a center for scanning probe microscopy, nanoimaging and nanomaterials. During these formative years for nanoscience, pioneers in scanning probe microscopy and its applications – including some from Basel – had shown the world how to “see” and “manipulate” individual atoms.

With an eye on these pioneering origins, the SNI sets its sights firmly on the future. With new knowledge and methods, it seeks to renew its focus on imaging, understanding and engineering matter at the nanometer scale.

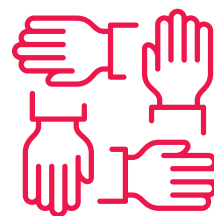
As an established hub for research, development and applications of **nanoscale imaging**, the SNI will concentrate its efforts in this foundational area of nanoscience. Only by “seeing” at the nanoscale, can we truly understand nanoscale phenomena.

With this focus, we intend to make nano visible.

In order to address problems in materials science, quantum science, life science, medicine and the environment, the SNI will use this understanding to manipulate materials at the nanometer scale. This focus on **nanoscale fabrication** is part of the SNI’s vision to bring the benefits of nanoscience to industry and society at large.

With this focus, we aim to build the future from the nanoscale up.

The integration of our fundamental research, our educational offerings and the SNI’s existing service units, the Nano Imaging Lab and the Nano Fabrication Lab, into these focus areas will strengthen our identity and maximize our impact.



Collaborate

The SNI aims to deepen and expand its **network**, the **collaborations** that underpin it, and its members’ **identification** with the institution.

The connections between the members and institutions must be reinforced and nurtured. Members should identify with the SNI as a research institution and a place of study and be motivated by its vision and strategy.

The **interdisciplinary** nature of nanoscience must be emphasized and the SNI’s role of bringing diverse researchers together for common goals must be stressed. Collaboration should be emphasized not only between disciplines but also between academic and industrial partners. Only in this way will our discoveries and developments be put to practical use and have the greatest possible impact on society.

We ought to encourage our members’ propensity to collaborate and to embrace new ways of thinking. These are the attributes that set us apart from traditional departments and research institutions.



Adapt

In order to keep up with rapid changes in technology, research and society, the SNI must **modernize its infrastructure, its curriculum and the way it presents itself to the outside world.**

Today, nanoscience and technology are even more ingrained in our everyday life than at the founding of the SNI almost 20 years ago. There is hardly an industry that does not face a challenge related to nanotechnology.

However, the tools required to do nanoscience have developed. And how we talk about the challenges and how we address them, has also changed and continues to evolve.

Staying at the cutting edge of current nanoscience, requires the SNI to simultaneously invest in modern infrastructure, keep its educational program up-to-date and be agile in its structure.

This entails more than just developments in the nanosciences. For example, we will also monitor how applications evolve thanks to artificial intelligence and implement them into our work – for example, in nanoimaging and the training of early career researchers.



Impact

The SNI aims to have a positive **impact on the development of our society** both through basic and applied research and through the education of dedicated young scientists.

On the one hand, advances in nanotechnology may hold the key to solving a number of important problems, for example in medicine or in the energy sector. Nanofabrication and nanoengineering also provide the basis for modern circuits and quantum components that could give rise to completely new developments in areas such as sensor and computer technology. For this reason, it is crucial to maintain and nurture the world-leading expertise of our network. In addition, we will position the SNI as a leading institution in nanoscience research, as well as actively supporting innovation in collaboration with industry, technology and knowledge transfer, and the founding of start-ups within our network.

On the other hand, to meet the challenges of the future, we need young people trained at the highest level, who can work at the interfaces between different disciplines. The SNI must continue to educate young scientists with a broad understanding of the natural sciences and an eye for applications. To reach this, they will get insights into the world of entrepreneurship earlier in their education.

To achieve sustainable success, society will also need to remain open to new technologies and solutions. For this reason, the SNI is committed to reaching the public and to informing it about the opportunities and risks offered by nanotechnology.



Network

**Interdisciplinary and interinstitutional,
with common goals and strong cohesion**

The SNI is an interdisciplinary network in which researchers from Northwestern Switzerland – at academic research organizations together with partners from industry – work on fundamental and applied nanoscience and nanotechnology projects that have the potential to **impact** society. For the future, it is essential that the SNI **adapts** to today's competitive environment by redoubling and refining its efforts to contribute to society via research, education, and exchange with industry in Northwestern Switzerland, especially in our **focus** areas of nanoscale imag-

ing and nanoscale fabrication. These goals can only be met with a robust, comprehensive and well-recognized network, which allows us to optimally **collaborate**. Frequent promotion of the interdisciplinary SNI network and attractive research funding will ensure a dynamic collection of SNI members and will attract excellent new researchers. Increasing contacts with other national and international institutions and networks active in the field of nanoscience and nanotechnology will further enrich the work of the SNI.

Ensure excellence and interdisciplinarity

The SNI will intensify its efforts to attract excellent researchers from different disciplines in Northwestern Switzerland to actively participate in SNI projects. In particular, we will seek to connect to researchers from academia and industry in emerging fields of nanoscience including, drug delivery, regenerative medicine, energy storage, environmental sensing and clean-up, quantum technology and meta-materials. Within the network, we will continue to support an open, critical and respectful culture of discussion that allows new approaches to be pursued in our scientific focus areas of nanoimaging and nanofabrication.

- Expand network of researchers, students and industrial partners.
- Provide frequent information about SNI-supported projects (both basic science and applied).
- Organize SNI information events beyond the boundaries of the network.

Strengthen identification with the SNI

SNI members from its various member institutions are ideal multipliers, who can support efforts to increase the SNI's visibility nationally and internationally. To this end, it is crucial that SNI members not only view the SNI as a source of funding, but also identify with it as an organization and make use of and actively support SNI offerings, for example in science communication.

- Expand internal communication between management and researchers.
- Increase involvement of the Executive Committee with SNI management by organizing in-person and digital meetings.
- Provide time and space for networking at internal events (Annual Event, Nano-Tech Apéro).
- Support events organized by members of the network, e.g. seminar series or conferences.
- Plan and aim for an SNI building as a center for cutting-edge facilities and a common physical space for the network and its members.

Activate exchange with the national and international nano community

The work at the SNI also benefits from the exchange between researchers and organizations active in nanoscience. The SNI has already established itself within Switzerland as a reliable partner of the Swiss Micro- and Nanotechnology Network (Swiss MNT) and organizes the annual Swiss NanoConvention (SNC) in Basel every 4–5 years. The SNI will continue to be involved in the SNC and, thanks to its excellent contacts, will bring renowned international nanoscientists to Basel for this national conference. In the future, we will intensify our efforts to invite internationally renowned researchers to Basel – not just for the SNC.

- Invite renowned scientists as guest researchers.
- Organize the Swiss NanoConvention in Basel every 4–5 years.
- Support conferences organized by SNI members.

In the future, we will strengthen our collaboration with other international nanocenters. Thereby we aim at cooperations in the field of PhD School and studies, but also concerning further research collaborations.

- Organize exchanges with other national and international doctoral programs.
- Establish contacts with researchers of other nanocenters and aim to organize joint conferences.

Education

Training specialists with a broad foundation to work on society's future challenges

The Swiss Nanoscience Institute offers a comprehensive, practice- and application-oriented education in nanoscience. The bachelor's program is designed to give students a broad foundation in the natural sciences. Once in the master's program, specialization begins and continues in the SNI PhD School. Interdisciplinarity plays a fundamental role in both the bachelor's and the master's programs as well as in the SNI PhD School, so that master's and PhD students learn the "languages" of the various disciplines of nanoscience. They become specialists in their fields of research and, at the same time, generalists with a broad understanding of different disciplines. This background makes our graduates ideally suited to contribute exactly

where the most innovative and **impactful** nanoscience is being done, i.e. at the interface of various disciplines. Given the importance of communication and team work to such interdisciplinary research, an emphasis on networking and **collaboration** is built into the curriculum. In the future, the SNI will continue to **adapt** its curriculum, to line up with the **focus** areas of nanoimaging and nanofabrication, as well as to keep up with the latest developments both in how we understand nanoscience and the methods we use to do it. Ultimately, our aim is to produce technically skilled experts, who are ready to work and lead in modern research and industry.

Increase student numbers

After early excitement around “nano” in the 2000s, student numbers have declined and have been fluctuating despite constant and intensive outreach activities.

The study coordination team aims to improve its coordination with the outreach team to reach more pupils with information about the nanoscience curriculum and its benefits. The Nano Students Association and individual, particularly active students and alumni will continue to be involved in information events and promotional activities.

- Continue participating in various prospective student fairs (*Maturandenmesse*) throughout Switzerland.
- Encourage nanoscience students to go to their former schools as ambassadors to advertise the study program.
- Re-develop a program for Bachelor Info Days according to the modified concept by the university.
- Develop new outreach activities to address potential students.
- Present female role models from the SNI network to specifically address potential female students.

Increase the appeal of the nanoscience curriculum

The SNI will evaluate and initiate various measures to make the nanoscience curriculum more appealing to potential students and to attract new target groups.

- Continually update the curriculum with new courses, such as with the recent implementation of a specialization in “medical nanosciences” and its associated courses in the bachelor’s program.
- Update the presentation of the existing offerings through new titles that captivate and engage.
- Evaluate the possibility of offering the bachelor’s program in English to allow international students to start their education in nanoscience in Basel.
- Develop a course on “Innovation” in close collaboration with the University’s Innovation Office.

Embed the nano curriculum more deeply into the SNI

The SNI management team already works well together, but the nano curriculum, network, research, service and outreach activities could be linked more tightly. Thus, one goal for the future is to reflect the focus topics of nanoimaging and nanofabrication in the studies and integrate not only the Nano Imaging Lab but also the Nano Fabrication Lab into education.

Furthermore, the focus areas of materials science, quantum technology, nanomedicine and environment will also be reflected more and more in the study program.

The Nano-Argovia applied research program offers a valuable insight into the world of applied nanoscience research – which, in future, we would like to provide to our nanoscience students.

Likewise, the SNI team plans to connect students with alumni working in industry. In this way, the SNI will encourage its students to build a network with representatives from local industry, thus supporting and facilitating their entry into professional life. Increased contact between students and industry will also help the SNI team to better understand industry needs in terms of the content of the study program.

- Develop a new concept for block course in the Nano Imaging Lab and new block course in the Nano Fabrication Lab.
- Introduce lectures given by the heads of the NI Lab and the NF Lab.
- Implement a seminar series for students with researchers participating in the Nano-Argovia program.
- Improve the network of students and alumni.
- Organize networking and information events for students at companies in the region.

Increase visibility and international recognition

The SNI PhD School was founded in 2012, when there were still few similar graduate programs. Today, by contrast, various doctoral schools exist in related disciplines and at other universities in Switzerland and abroad. It is, therefore, no longer a unique selling point to offer postgraduate students the membership of a graduate school and to let them benefit from additional offerings such as workshops or winter/summer schools.

What is unique, however, and, at the same time, challenging about the SNI PhD School is its diversity and interdisciplinarity. Not only are different disciplines represented in our network, such as medicine, pharmacy, biology, chemistry, physics and materials science, but more than half of all doctoral research projects are supervised by project leaders from different departments at the University of Basel or other research institutions in the SNI network (Paul Scherrer Institute, University of Applied Sciences Northwestern Switzerland, Department of Biosystems Science and Engineering at ETH Zurich Basel or CSEM Allschwil). This diversity gives doctoral students insights into research areas and institutions outside their focus. It broadens their horizons far beyond their own field of research and opens up diverse career opportunities.

In future, we will better communicate the scientific excellence of the doctoral projects and the research teams, as well as the advantages of belonging to the SNI. On the one hand, we will further increase the visibility of scientific results published in renowned scientific journals and make them accessible to a broad audience. On the other hand, we aim to strengthen networking among the researchers involved in the PhD School to create a stronger feeling of association, which will help to raise the visibility of the SNI PhD School at all levels of society and among the local research environment.

More active promotion of the program via personal contacts within the institutions of the SNI network, at other research institutions in Switzerland and at European nanocenters should increase the visibility of the SNI and what it has to offer to young scientists.

The possibility of pursuing new approaches, such as a direct, accelerated transition from the bachelor's to the PhD program similar to that in the USA or collaborative PhD projects with other nanocenters, will be evaluated in the coming years.

Through the various measures, we expect to attract more highly qualified candidates for the projects, thus further strengthening the SNI PhD School.

- Disseminate scientific results via social media.
- Promote the SNI service units (NI Lab and NF Lab) to all PhD students and project leaders as great added value for all projects.
- Continue to organize informal events for PhD students to get to know each other and improve the network.
- Target the PhD project calls at projects from the SNI's focus areas of nanoimaging and nanofabrication in materials science, life science, medicine, quantum technology and the environment.
- Proactively approach potential new project leaders at the various institutions within the SNI network and inform them about the offers and benefits of the SNI PhD School.
- Establish or intensify contact with nanocenters in Switzerland and Europe. A long-term goal would be a joint European nanoconference.
- Regularly advertise the SNI PhD School at conferences and events.
- Evaluate a call for collaborative projects in cooperation with other nanocenters.

Optimize collaboration of management with principal investigators

The principal investigators involved in the SNI PhD School come from different institutions and change each year. While guidelines exist for the annual process of recruitment, communication with PIs about the process and the SNI PhD School in general will be optimized in future.

- Introduce a webpage and information event with current and potential principal investigators to better inform them about the process, expectations and opportunities.
- Optimize the application and evaluation process with new online tools, optimized procedures and a professional hiring process.
- Evaluate and improve the advertisement of SNI PhD positions on different platforms and mailing to other universities and nanocenters in Europe in order to attract the best possible candidates.

Continuing education beyond scientific aspects

The SNI doctoral students benefit from various exclusive offers such as the Rhetoric Workshop and the Winter School “Nanoscience in the Snow”. During these courses, they learn new skills and interact with invited senior scientists.

In general, this additional program, beyond the research work, is highly appreciated by the PhD students. We will continue this offer and regularly adapt it to the ever-changing needs.

We plan to intensify contact with the nanoscience alumni organization. We aim to link current doctoral students with graduates from the SNI PhD School and of the nanoscience program. In doing so, we also expect new connections with companies in the region – where alumni are employed – thus expanding the SNI network informally well beyond the existing actors. Specifically, this will also help the SNI graduates envision and commence a career in industry, based on direct contacts and collected information.

- Continue the already established courses specifically developed for SNI doctoral students.
- Develop a new course on innovation and start-up founding, in cooperation with the Innovation Office of the University of Basel.
- Organize networking events between alumni and doctoral students.
- Allow companies in the SNI network to place job offers on the SNI website.
- Organize networking and information events at companies in the region especially for students.

Research

Excellence in nanoscale imaging and fabrication for the benefit of society

As nanotechnology becomes ever more common in our everyday lives, nanoscience research has become more relevant to society and more competitive than ever before. While applications in this area abound and its potential continues to grow, the SNI must **adapt** to what has become a crowded field populated by numerous nanocenters and nanoinitiatives around the world. Taking inspiration from our roots as pioneers of scanning probe microscopy, the SNI must concentrate its efforts on its strengths in order to maximize its **impact**. By **focusing** the efforts of our researchers in the areas of nanoscale imaging and nanoscale

fabrication, we aim to stay at the forefront of modern developments and to avoid diluting our finite resources. Despite setting some limits on the research pursued by the SNI, these focus areas span our interdisciplinary network. They encompass projects in physics, chemistry, biology, pharmaceutical sciences and medicine, as well as include both basic and applied research. In this sense, a clearly defined research direction across subfields, will ease and foster more **collaboration**, by encouraging groups to structure research projects around the SNI's goals.

Guide research focus

The SNI will direct its member researchers to the areas of nanoscale imaging and nanoscale fabrication with particular emphasis on projects involving quantum technology, nanomedicine, materials science and sustainability via its internal funding calls.

By targeting the annual SNI PhD School call, the call for applied Nano-Argovia projects as well as occasional infrastructure calls at particular topics within our focus areas, the SNI will guide its members in a common direction. After several years, the result will be a more cohesive and impactful research portfolio with increased interdisciplinary and inter-institutional synergies. Efforts will also be made to more clearly organize researchers around their focus areas.

- Target funding calls at focus areas (nanoimaging and nanofabrication).
- Organization of meetings on nanoimaging and nanofabrication for researchers from different disciplines in collaboration with the NI Lab or the NF Lab.
- Connect SNI principal investigators (research group leaders) with the Nano Imaging Lab and Nano Fabrication Lab (services units); the research groups will represent the research arm, and the NI and NF Labs the service arm of the focus area.

Collaborate and connect

In order to establish our position as a center of excellence for nanometer-scale imaging and fabrication in Europe, in addition to supporting and encouraging research, we must connect with local, national and international experts. The SNI management will oversee a new push to connect and reconnect with players throughout the field of nanoscience and nanotechnology, in particular with those in our focus areas.

- Organize high-profile international conferences on focus topics.
- Reconnect with national research centers (e.g. EMPA, ETHZ, EPFL) to seek ways to cooperate, with an emphasis on our focus areas.
- Connect with local industry via the Nano-Argovia program with an emphasis on our focus areas.

- Reach out to other nanocenters in Europe via principal investigator “ambassadors”.
- Take advantage of the alumni network within local industry and academia to foster new connections.
- Consider special funding calls that involve international collaborations.

Investments and facilities

In order to keep its research efforts at the cutting edge of nanoscience and to compete with the top nanocenters in the world, the SNI must continuously look to the future. We must invest in the latest infrastructure and equipment, so that our members have the tools to do state-of-the-art research and so that the services offered by our service units are up-to-date. We must also ensure that the SNI offers facilities and an environment that will attract the world’s top nanoscience researchers. Modern facilities attract top principal investigators and students, and the environment created by this combination brings in even more talent. Although already an excellent network, the SNI lacks facilities and many of its researchers and one of its service units (NF Lab) are housed in aging buildings. Investments must be made to ensure that the SNI maintains its excellence and has the opportunity to improve even further.

- Invest in essential infrastructure for research groups to stay at the cutting edge.
- Invest in state-of-the-art tools for services units, especially for the NF Lab, which is in a build-up and reorganizing phase.
- See through planning and completion of the SNI building with specially designed space for both the NF Lab and NI Lab.

Services

State-of-the-art research support for academia and industry

The reorganization of the SNI's services has brought together a variety of state-of-the-art nanoimaging and nanofabrication tools, highly skilled personnel, and years of experience and knowledge under the umbrella of the Nano Technology Center. Using the success of the Nano Imaging Lab as a model, in 2022, we have added the Nano Fabrication Lab to the services that we offer. At the University of Basel, the SNI therefore offers a unique service unit for micro and nanofabrication whose services are also available to customers from outside the network.

With the two service groups, in the form of the Nano Imaging Lab and the Nano Fabrication Lab, the SNI **focuses** its services on

the two areas of nanoimaging and nanofabrication, providing its members and customers from industry and academia with access to the infrastructure they need to remain at the cutting edge of nanoscience.

Many of these tools are expensive, challenging to maintain, and require skilled operators with extensive experience. Keeping knowledge and equipment up-to-date are crucial to conducting **impactful** research in nanoscience and enable us to **adapt** to new developments. These facilities, which are used by researchers from different departments and institutions, and the skilled technicians who work there serve as catalysts for **collaboration across the network**.

Improve and maintain facilities and further develop the knowledge base

In order to continue offering state-of-the-art service and support in imaging and nanofabrication to SNI research groups and external partners, the Nano Technology Center of the SNI must steadily upgrade and improve its infrastructure and equipment. Furthermore, investment in its professional, technical and administrative staff is also required in order to maintain its rich portfolio of expertise. Investments are particularly important when it comes to positioning the newly founded Nano Fabrication Lab as a competitive clean room facility and establishing this service unit as the basis for investigating the quantum world.

On the other hand, for the Nano Imaging Lab to retain its established excellence, sustained investment is equally important. To meet these needs, we will follow a campaign of sustained infrastructure investment aimed at giving the SNI the tools to compete with the world's best nanoscience centers.

- Invest in state-of-the-art tools and equipment for imaging and nanofabrication.
- Grow competences through training of staff.
- Evaluate possibility of applying for funding via national call for "Quantum Infrastructure" to provide equipment and clean room infrastructure for the NF Lab.
- Use available funds to bring the NF Lab as close as possible to standards of other internationally recognize nanofabrication facilities within the existing building at the University of Basel and the rented clean room facility at the D-BSSE.
- Plan for a dedicated clean room for the NF Lab

and specialized microscopy space for the NI Lab in the SNI building.

Integrate research groups within the Nano Technology Center

The Nano Imaging Lab and the Nano Fabrication Lab are driven to work at the cutting edge of nanoscience and nanotechnology by SNI researchers and pioneering projects. The challenges posed by researchers motivate the development of new techniques and methodology. To catalyze such exchange, the SNI seeks to bring its researchers and service personnel in closer contact.

- Embed the SNI research group leaders in the Nano Imaging Lab and Nano Fabrication Lab.
- Organize events and workshops of the Nano Imaging Lab and Nano Fabrication Lab that involve researchers from the network.

Expand the network of clients and partners

The SNI wishes to expand the portfolio of local industries and start-ups served by the Nano Technology Center of the SNI. This can be achieved by keeping current and potential clients informed about developments at the Nano Technology Center, as well as organizing networking and information events. We intend to take advantage of Basel's position as a hub for life sciences and a home to many potential partners to facilitate networking and communication.

- Organize information events with companies and start-ups.
- Connect with companies within the life sciences hub.
- Publish and disseminate the NI Lab newsletter and develop an NF Lab newsletter, describing developments and upgrades in available services.
- Coordinate with local departments and organizations (e.g. NCCR SPIN, Biozentrum, D-BSSE) interested in improved clean room facilities to upgrade available offerings.

Knowledge and technology transfer

Networking with companies and encouraging innovation

Effective knowledge and technology transfer is vital in order to use the nanosciences successfully for the **common good**. Only by transferring the applications of our research findings to companies can it be possible to harness the potential of innovations developed in the research groups of the SNI network (CSEM Allschwil, D-BSSE, FHNW, PSI, ANAX-AM, Swiss PIC and the University of Basel). To actively support this knowledge and technology transfer from the outset, the SNI launched the interdisciplinary Nano-Argovia program at the time of its founding. This program sees researchers from the SNI network and from industrial companies in Northwestern Switzer-

land engage in technology transfer with a view to exporting research findings and expertise from academia into industry and jointly developing new products and applications.

In the future, we will incorporate our **focus areas** of nanoimaging and nanofabrication into this applied research program more closely in order to promote sustainable innovation in the fields of materials science, quantum science, the life sciences, medicine and environmental science. When it comes to training young researchers, we will also establish programs on the topic of innovation with a view to encouraging entrepreneurial thinking.

Collaboration with companies in the Nano-Argovia program

In the future, the interdisciplinary applied research Nano-Argovia program will continue to serve as the primary vehicle for knowledge and technology transfer. To this end, we will maintain our support for projects with a term of 1-2 years in which researchers from at least two different institutions of the SNI network work with representatives of an industrial company from Northwestern Switzerland.

The SNI will bolster its efforts to expand the network of companies and researchers who are informed about the Nano-Argovia program, take part in related events, and participate in research projects in the capacity of project partners. The Nano Technology Center will also play a greater role in applied research projects, approaching companies and integrating them into the Nano Technology Center as external users. We will maintain our close collaboration with the Hightech Zentrum Aargau, which has become an established hub for knowledge and technology transfer in the Canton of Aargau, and we will continue to promote joint activities. The SNI will also seek to intensify collaborations with Basel Area Business & Innovation.

- Greater participation by the Nano Technology Center in Nano-Argovia projects.
- Outreach manager will partly focus activities on expanding the industrial network and collaborating with the Hightech Zentrum Aargau and Basel Area Business & Innovation.
- Expansion of industry network via alumni of the nanoscience degree program and the SNI PhD School, as well as via customers of the Nano Technology Center.
- Regular information and networking events as part of the Nano-Argovia program with representatives of academia and industry.
- Extended marketing activities regarding the benefits and successes of the Nano-Argovia program via social media and other established information channels of the SNI.

Integrating innovation into training

We will develop new formats in the degree program and the SNI PhD School in order to inform students and doctoral students about the topics of innovation and knowledge and technology transfer, to provide them with valuable insights, and to give them the necessary tools even before they graduate. By raising awareness of innovation among students and doctoral students at an early stage, the aim is to prepare them for the dynamic and rapidly changing nature of nanoscience and the opportunities it provides. Students will learn to think outside the box as well as developing entrepreneurial skills and an entrepreneurial approach to risk-taking. Participants will gain the expertise they need to identify and implement useful applications of their research findings – helping us to tackle the challenges of today and tomorrow through innovation.

- Development of a workshop for doctoral students from the SNI PhD School on the topic of innovation and the founding of start-ups in collaboration with the Innovation Office of the University of Basel.
- Development of a lecture course on innovation and change management for nanoscience students at the University of Basel in collaboration with the Faculty of Business and Economics of the University of Basel.
- Lunch talks for nanoscience students and doctoral students with speakers drawn from alumni working in industry or who have themselves founded start-ups.
- Development of formats and platforms for the regular exchange of ideas between alumni, students and doctoral students.

Expert feedback on further development

Innovation and knowledge and technology transfer are key missions that the SNI wishes to further strengthen in the future. As well as the above points, the SNI will establish an expert body in the form of an “Industrial Advisory Board” to evaluate the implemented stimulus measures and discuss changes to them, as well as proposing new measures and tools.

Outreach

Generate positive associations with “nano”

The general public’s knowledge about nanoscience is limited. The media cover only a small sampling of the latest breakthroughs and opportunities emerging in nanoscience and nanotechnology, often without emphasizing their “nano” components. In schools, nanoscience is not a subject of instruction, making it difficult for students to envision studying nanoscience and to understand to which careers this could lead. In the coming years, the SNI will continue efforts to educate the general public on what “nano” is and how it contributes to society.

Using success stories, we will show how topics in our **focus** areas have a positive **impact** on current and future challenges. We will connect with students at cantonal schools and high schools in Switzerland to inform them about the nanoscience curriculum at the University of Basel and the diverse career prospects it offers. We will **adapt** our outreach programs depending on the success of the various formats and will **collaborate** with partners at schools and in education departments to reach our target audiences.

Addressing potential students

In future, the SNI will increasingly target young people in the 15–19 age group – not only to inform them about natural sciences in general and nanoscience specifically, but also to interest pupils in the nanoscience program at the University of Basel. To this end, we will expand existing contacts with various schools in Switzerland and with organizations such as Technorama and develop special formats for this age group.

- Organize laboratory internships for students of the NAWIMAT branch in the canton of Aargau and for highly gifted students.
- Provide technical support for *Maturaarbeiten*.
- Participate in the “Schnupper Summer and Winter School” of the University of Basel.
- Expand workshops and laboratory visits for schools.
- Continue collaboration with the Swiss Academy of Engineering Sciences SATW with continuous development of contributions.
- Encourage involvement of students who report on their studies and act as contact persons for pupils.
- Further develop accompanying print and digital media, which report on the studies as well as possible careers and show the advantages of the interdisciplinary education.
- Consider cross-border outreach activities to address students in the region.

Inform the general public about nano- and natural sciences

Furthermore, in outreach events for the general public, we will primarily target children and young people, since children, in our experience, often respond enthusiastically to interactive offerings and, in many cases, adults are also excited by the various formats. In addition, we also reach teachers, parents and grandparents, who accompany the children who participate or get the information at home while looking at materials the children created or received. We adapt our formats depending on the target age group and the event, but always make sure that they are interactive, fun to participate in and enhance experimenting and thinking.

- Organize workshops at elementary school and kindergartens, booths at markets and offers at science festivals, MINT on the move, lab tours.
- Cooperate with museums to explain different aspects of the natural sciences and nanoscience.
- Develop projects that combine art and science.
- Produce animated publications.

Through digital channels, we will continue to provide a broad audience with insights into laboratory work, publish success stories from our network, and introduce researchers from different disciplines. In doing so, we strive to get young scientists in front of the camera, presenting their diverse research projects and results in an easy-to-understand language. We continue to use social media to do this and to analyze and professionalize our material so that we can achieve even greater reach in the future.

- Focus on the production of videos and short texts.
- Carry out a data-based analysis of our YouTube channel to make existing videos available to more people

Adult education

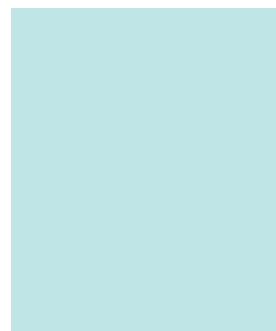
We would like to continue to serve adults interested in natural sciences in general and nanoscience and nanotechnology in particular with exciting information. To this end, we will maintain and expand our cooperation with adult education centers in Northwestern Switzerland. We continue to involve researchers from the network to give lectures and to provide input on different aspects of nanoresearch so that the outreach team can organize small exhibitions or interactive experiments. Video material on nanoresearch on digital channels supports our adult education activities.

- Continue existing contacts with the *Volkshochschule beider Basel*.
- Establish contacts with the adult education center in the canton of Aargau and work out an offer.
- Continue sponsoring and advertising events such as the Science Slam, which specifically address adults with an interest in science and research.
- Continue close collaboration with the University's Communication and Marketing group.

About this publication

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