University of Basel

Swiss Nanoscience Institute

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

SNI INSight

Showcasing research and activities of the Swiss Nanoscience Institute

August 2020

Studying in the age of the coronavirus

Students talk about their experiences

Exploring the aging process

Award for the best master's thesis

Hydronics

An interdisciplinary investigation

Multifaceted and up-to-date

Coronavirus research in the SNI network

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Editorial

Dear colleagues,

I hope you are all well in spite of the unusual times in which we still find ourselves.

I am delighted to see that our labs are up and running again, and that we can return to our research. But we must be under no illusions – the coronavirus pandemic has not gone away, and neither have the issues associated with it. We must continue to follow the rules, maintain safe distances, and protect ourselves and others wherever necessary and possible.

We have therefore decided, with a heavy heart, to cancel our Annual Event in Lenzerheide. We would have dearly loved to meet with you all in person for some fascinating research discussions, but our well-being must take precedence. We cannot and would not want to keep our distance at the Annual Event, nor do we want to restrict the meeting to a small group. This leaves us with no option but to postpone the network's interactive and personal get-together for a while longer.

Decisions of this kind are never easy. Over the past months, the only sensible course of action has been to forgo many activities that bring us joy and motivation. For this and other reasons it has been a trying time, creating serious difficulties for many of us. We care deeply about how our nanoscience students and doctoral candidates have fared, so we asked some of them to share their experiences of the last few months.

Daniel Stähli, a former nanoscience student, was fortunate to have written his master's thesis last year, as this allowed him to enjoy an exciting and instructive time at Stanford University in California. His thesis on ageing phenomena, which made a substantial contribution to a publication in the journal Nature, earned him the 2019 award for the best master's thesis in nanoscience at the University of Basel.

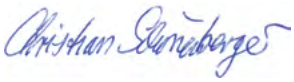
Further prizes went to five young nanoscientists who wrote outstanding publications as lead authors. The PhD Awards are normally announced by the Swiss Micro & Nanotechnology Network at the Swiss NanoConvention (SNC), which was scheduled to take place in Basel in July this year. Although the SNC was postponed until June 2021, we still gave out the PhD Awards – which are sponsored by six Swiss firms – as planned. In this issue of SNI INSight, you can read all about the papers for which the young researchers earned their prizes. Furthermore, you can admire the fascinating images distinguished with this year's SNC Image Award, which also went ahead in spite of the postponement.

Another fantastic piece of news is the approval by the Swiss National Science Foundation of the interdisciplinary Sinergia Hydronics project, an innovative research collaboration led by Ilaria Zardo of the University of Basel's Department of Physics. Zardo's team will work with colleagues from EPFL, Empa and IBM to study charge and heat transport in order to explore new ways of controlling electrical and thermal currents.

Countless research groups around the world are currently devoted to studying SARS CoV-2 and Covid-19. The SNI network is no exception, with various teams doing their part to expand our knowledge of the novel virus and improve diagnostics and treatment options. Several of these projects are presented in our overview article.

I hope you enjoy this issue devoted largely, but by no means exclusively, to the coronavirus pandemic. And last but not least, stay safe!

Kind regards,



Prof. Christian Schönenberger, SNI Director

Studying in the age of the coronavirus

A few examples from nanoscience students and the SNI PhD School

We have all had vastly different experiences over the past few weeks and months. Some people may have found that they are more efficient and productive when working from home. Others may have been contending with major worries, struggled to find the peace and quiet they need at home, or have even fallen sick themselves. We asked some students from the nanoscience degree program and the SNI PhD School about their recent experiences, the problems they have faced and what they have learned during this time.

Elaine Schneider, Julian Köchlin, Nicolas Brunner, Patrick Weber, Sarah Müller and Timon Baltisberger have given feedback from the nanoscience program. Doctoral students Alexina Ollier, Mehdi Heydari, Paolo Oliva, Stefano Di Leone and Thomas Mortelmans have also shared their experiences of the past few weeks.

An internship with no significant obstacles

Patrick began a six-month internship at Anjarium Biosciences back in February, and was able to complete it with no major restrictions. He really enjoyed his time with the biomedicine start-up, which was founded by nanoscience alumnus Joël de Beer, and can definitely see himself working in a similar environment after his doctorate. He looks back on these months fondly, despite not being able to see his friends or family. The time he would normally have spent seeing friends and attending cultural events has instead been used for self-reflection, among other things. “In today’s hectic world, we rarely have the opportunity to relax, let our thoughts drift and consider our place in society and the world as a whole,” he comments.

Patrick Weber (right) was able to complete his internship at the start-up Anjarium Biosciences, founded by Joël de Beer (left), with almost no restrictions. (Image: P. Weber)

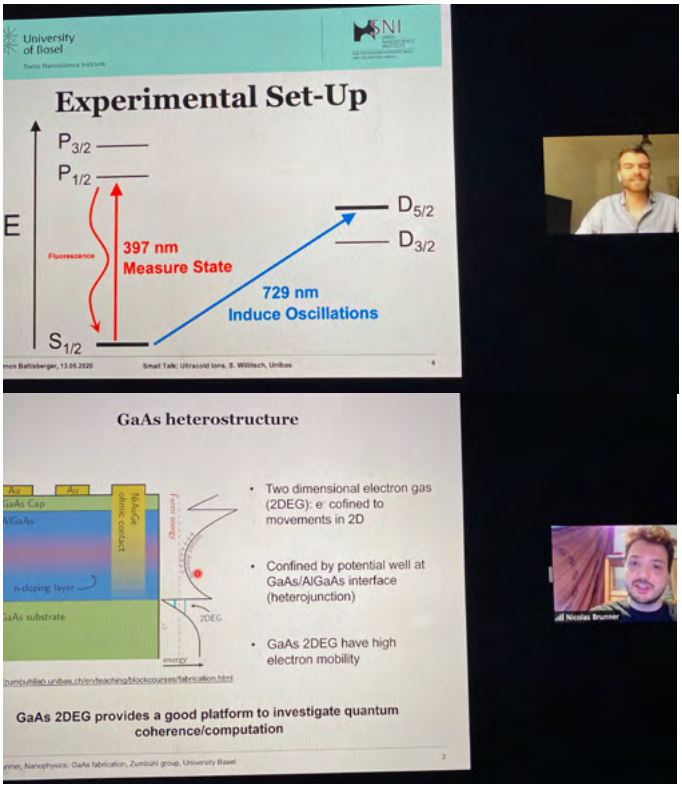
Project work in Luxembourg

Sarah Müller has also found positive aspects to the last few months – she has had more time to herself and other people seem more relaxed. She started her project work on marine phytoplankton at the University of Luxembourg in the middle of February. She experienced a great deal of uncertainty at the start of the coronavirus crisis – it was unclear whether she would be able to finish her work as planned on lipids as biomarkers for physiological stress. In the end, she was able to continue her lab experiments until Luxembourg went into lockdown in the middle of March. After that, she continued working from home – first in Luxembourg, then in Basel. Sarah has also missed her partner, friends, parents and siblings, and simply being able to meet them for coffee. However, she hopes that the past weeks have taught her to be a little calmer.

Online events have advantages too

Over the last few weeks, numerous online lectures

Sarah Müller successfully completed her project thesis while working from home. (Image: S. Müller)



Lectures, like the "Smalltalk" conference devoted to the block courses, took place virtually. Timon and Nicolas are among the students who took part.

have been scheduled for the early semesters of the bachelor's program. Elaine, Timon and Nicolas actually found this to be quite good, as it allowed them to manage their time as they wished. "The advantage of video and audio recordings is that I can replay anything that isn't clear and work through the lecture at my own pace," adds Nicolas. "However, minimal contact with colleagues and students from later semesters has made it difficult to gauge how much I have learned and progressed," says Elaine. More generally, students have missed having contact with other students and their tutors and the opportunity to learn and practice together.

Changing habits

It hasn't always been easy to get used to learning at home, ignoring the many potential distractions and forcing yourself to take time off from studying. "It's great to have total flexibility when organizing your time, but this also makes it difficult to separate work and leisure," says Julian.

Elaine plays for a volleyball team, and has missed the way that sport offsets the other areas of her life. Others have found this to be the perfect opportunity to try new hobbies. Sarah has started practicing yoga and Nicolas has spent his evenings "cooking lots of new dishes and totally ignoring the tasty takeaway services around the Department of Physics."

Exhausting, yet inspiring

The students have also had to endure the uncertainty of the last few weeks. It was initially unclear whether written examinations would take place, which block courses would still be going ahead and, for example, whether the small conference on the "Smalltalk" block courses would be able to happen. A good solution was found for "Smalltalk" and a couple of other block courses; unfortunately, other projects and forms of work had to be postponed or cancelled altogether.

However, some students say that these experiences may have ultimately helped them to become more disciplined and confident, and also more laid-back. "It has definitely shown us that there are technical solutions for many problems," says Timon, referring not only to the university podcasts, but also the many conference calls to maintain social contacts.

The last weeks and months have also confronted the SNI PhD School students with a new situation, although all respondents said that they had been coping well.

Many weeks alone

Alexina lives in France and spent around six weeks at home in almost constant solitude – the rules on leaving the house were much stricter in France than

in Switzerland or Germany. “Every day was the same and I basically spent the whole time working – I live alone and didn’t have much else to do,” she says. She used the time to process her data. After four weeks, she started her first experiments, using her microscope at home at first then returning to the lab. She probably hasn’t lost all that much time – luckily, the experiments she started went well – but she missed the ease of talking to her colleagues and supervisor. “It’s so much simpler to pop into the office and ask them a question,” says Alexina. “On the other hand, this has helped me to become more independent.”

Stefano has had a similar experience. Although he lives in Germany (where the rules on going out were not as strict) and had more time to relax, he still felt like a prisoner. He also began by analyzing his data and then wrote a paper. Webinars and online lectures also helped him to make good use of his time. Nevertheless, he was delighted to be allowed back into the lab after eight weeks away. “This time has taught me just how important my social life is. Sometimes we don’t appreciate that enough. On the other hand, I was really impressed with how online courses and meetings were organized.”

Stefano is delighted to be back in the lab after many weeks working from home. (Image: S. Di Leone, Department of Chemistry, University of Basel)

Harder to separate work and leisure

Some doctoral students also mentioned the difficulties they experienced in taking breaks when working from home and developing a new routine when there is no physical separation between work and leisure. Paolo was one of the people who struggled with this aspect. He had already completed all of his experiments, so he wrote his doctoral dissertation and prepared for his virtual dissertation defense. Everything went really well and he learned to plan his days better, take more time for himself and remember that work shouldn’t always take priority.

Home working is valuable

Thomas used the first weeks of the coronavirus shutdown to conduct theoretical work such as simulations and to optimize the design of his microfluidics system. He was allowed back into the lab part-time from mid-April because he is currently working on a platform to demonstrate Covid-19 immunity, and these sorts of projects are currently being prioritized. He works in two different cantons at the University of Basel and the Paul Scherrer Institute (PSI), which meant he had to examine the different operational concepts and draw up detailed plans of when he wanted to work and where. He believes home working is valuable and would like to continue with this when he is not running experiments. Like everyone surveyed, however, Thomas says that regular contact with colleagues and friends is essential.

Loss of ease

Mehdi has missed this contact too, although he has been more productive than usual over the last few weeks. He tried to get extra testing time with the PSI’s highly coveted synchrotron light source and to progress with his experiments. While there have been very few restrictions on his scientific work, he has struggled to relax and enjoy his free time. He wasn’t afraid of the virus on his own account, but his concern for the people around him and his inability to help have made him feel depressed. Most of all, he has missed that feeling of ease and having nothing on his mind.

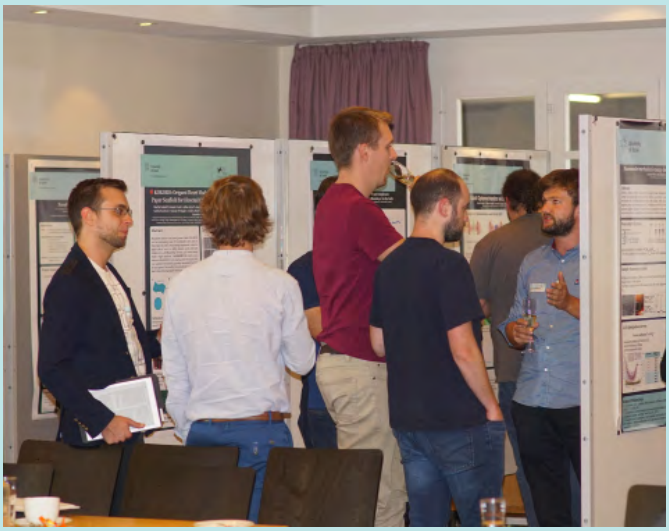
These are just a few, randomly selected examples of how some of the young people in the SNI network have been feeling over the last few weeks. They have managed well at this difficult time and can see positive sides to this extraordinary situation. We wish the respondents – and the rest of you – all the best and hope that you continue to remain healthy and to cope as best as possible in these challenging times.

SNI Annual Event

In light of the uncertainties inherent to the coronavirus pandemic, we have decided to cancel the SNI Annual Event.

Our colleagues' health is even more important to us than academic exchange.

We therefore look forward to seeing you at next year's Annual Event from September 9 to 10, 2021.



Nano Image Award

The fantastic images submitted by members of the SNI network really help our outreach materials to stand out. We are therefore pleased to announce that submissions are open for this year's Nano Image Award. The three winning photos will each be awarded CHF 300.

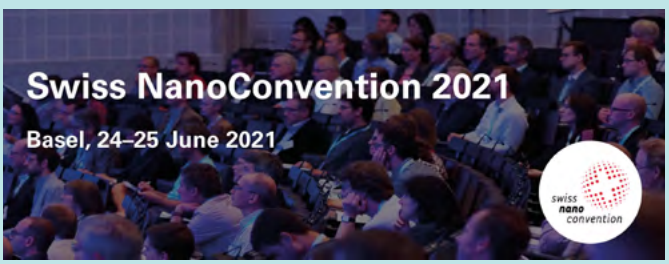
Please send your images of the micro and nano world to c.moeller@unibas.ch along with a title and short description by November 15.

We look forward to receiving a fascinating selection of beautiful images.

Swiss NanoConvention

The Swiss NanoConvention 2021 will take place on June 24 and 25, 2021 in Basel. The SNI will host the event in collaboration with the Swiss MNT Network.

Please add it to your diaries now!



Exploring the aging process

Daniel Stähli wins award for the best master's thesis

Daniel Stähli has won the award for the best nanoscience master's thesis in 2019. He wrote his excellent thesis about aging processes in the blood-brain barrier at Stanford University (Palo Alto, California, USA) in the laboratory run by Professor Tony Wyss-Coray, one of the leading researchers on the subject of aging. In his nine months at Stanford, Daniel not only had the opportunity to work with numerous scientific methods, but also came to appreciate his colleagues' optimism, enthusiasm and openness. Spending time in California was the perfect way to conclude his studies in nanoscience – a subject he would definitely choose again.

Interested in nanoscience from an early age

Even as a child, Daniel Stähli knew he wanted to be a scientist, and he continued to be fascinated by the sciences at the Kirschgarten high school in Basel. His decision to study nanoscience was prompted by the "Journey Through Worlds" (Weltenreise) event, in which the University of Basel takes visitors on a journey from the cosmos into the nano world. "I went to the "Weltenreise" at the Schauspielhaus theater in Basel with a fellow student. That was when we first heard about the interdisciplinary nano degree program. It sounded exciting and modern," Daniel recalls. They both went on to study nanoscience in Basel.

Project work and master's thesis were the highlights

Daniel found the bachelor's program to be fairly "jam-packed" and challenging, but also extremely educational. Looking back, he sees it as the ideal preparation for the subsequent master's program, which was much more his style. "It was great that the master's program allowed us to study three different areas in much more depth through two projects and a master's thesis. We were free to choose our subject areas and were given the support we needed to gain experience abroad," he says, summarizing what he

Daniel Stähli had a great time at Stanford, where he wrote an outstanding master's thesis.

believes to be the most positive aspects. In his first project, which he completed at the Department of Biomedicine in Professor Daniela Finke's laboratory, he studied the differentiation of stem cells and lymphocytes, which play a key role in tissue immune responses. In his second project, Daniel used an SNI travel grant to spend three months at the International Iberian Nanotechnology Laboratory in Braga (Portugal) with Dr. Pieter de Beule. Here he focused mainly on programming and statistically analyzing fluorescence microscope analyses of membrane proteins.

Success on his own initiative

Daniel knew that he wanted to go abroad for his master's thesis too. He was particularly interested in research on aging, so he searched the internet for research groups working on this topic. Professor Tony Wyss-Coray of Stanford University (Palo Alto, California, USA) is one of the experts in this field. He proved that transfusing plasma from young mice has a rejuvenating effect on older mice.

Daniel wrote to him and was quickly accepted. "However, spending time abroad like this involves a huge amount of administration, particularly if you want to go to the USA," he comments. Daniel first made contact in February 2018; he received confirmation from Stanford University in July and travelled to California in October for nine exciting and intensive months.

Role of the blood-brain barrier in the aging process

Daniel's master's thesis concentrated on the blood-brain barrier and its protein permeability. The blood-brain barrier is a selective barrier that shields the brain from the rest of the body and regulates and restricts the absorption of plasma proteins. It is formed of endothelial cells with the aid of pericytes and astrocytes. As a person grows older, and in cases of neurodegenerative diseases such as Alzheimer's, the barrier's extreme selectivity decreases and various substances can enter the brain that are not detected in young, healthy brains. It is important to know precisely how the blood-brain barrier works when treating neurodegenerative diseases – if the blood-brain barrier is intact, it also prevents therapeutic antibodies from getting into the brain.

Daniel investigated how the blood-brain barrier changes with age. Together with his supervisor, Andrew Yang, he developed a new method to test the permeability of the blood-brain barrier and examine the normal aging process of the blood-brain barrier in mice. First, they marked all proteins in the blood plasma. Then they studied which of these proteins were detected in the brain cells and in the endothelial cells that make up the blood-brain barrier.

They identified certain genes that support the absorption of plasma in the endothelial cells. The results showed that numerous proteins were able to pass through the blood-brain barrier. In young mice, these proteins are absorbed via specific receptors; in older mice, they do not have a specific route.

On the whole, however, the absorption of plasma proteins does not increase, but actually tends to decrease. Daniel was also able to show that the number of pericytes – one of the cell types that make up the blood-brain barrier – decreases with age.

His work not only proved which processes are triggered by the aging process, but also which proteins can break through the blood-brain barrier. In the future, these proteins could potentially be used as shuttles for therapeutic agents.

Unique experience

Daniel's nine months in Palo Alto were very special, and he wouldn't have missed them for the world. "I was very lucky to have such a good supervisor in Andrew. We worked a lot and extremely hard, but it was a great and exciting time." His (now award-winning) master's thesis wasn't his only crowning achievement – his data also contributed to a paper by

Further information

Wyss-Coray research team
http://web.stanford.edu//group/twclab/cgi-bin/index.html

Publication in «Nature»
https://www.nature.com/articles/s41586-020-2453-z

Other winners of the award for the best master's thesis
https://nanoscience.ch/de/ueber-uns/menschen/preise/

the team that has just been accepted for publication in Nature.

Daniel's lab colleagues were instrumental in making his experiences so positive. He was impressed by the optimism, energy and openness with which he was received by other doctoral students, postdocs and professors. "The whole Bay Area has a hugely motivating atmosphere. It is densely packed with excellent universities and leading life science companies. They work closely together, have tremendous resources at their disposal and anything seems possible," he remarks. Daniel wasn't the only one to be impressed. Tony Wyss-Coray, his supervisor at Stanford, speaks very positively of Daniel's dedication and performance: "We have been thoroughly impressed by Daniel's passion and dedication to science and his aptitude for experimental research. We would have loved to keep him longer."

The next step – a doctorate

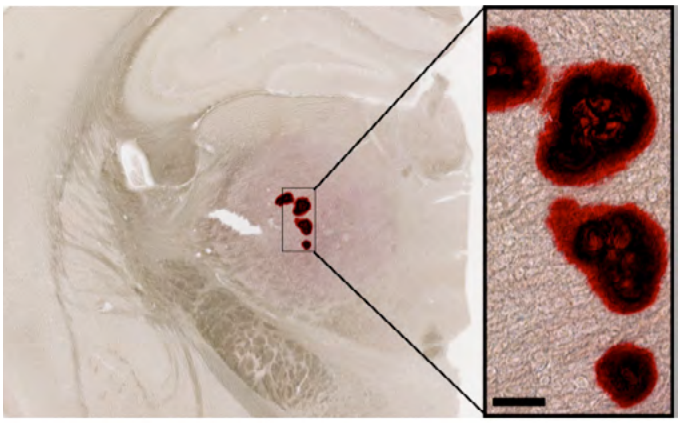
However, Daniel will probably stay in Switzerland for the next stage of his scientific career. After six months of civilian service – which he is about to complete – he would like to begin a doctorate, and is looking at various groups at the University of Basel, ETH Zurich and EPF Lausanne. He would like to pursue his interests in various fields of life science.

A good decision

Looking back, he is glad that he opted for nanoscience seven years ago. He still values the wide range of experiences he has been able to gain – not only in various subject areas, but also in different countries thanks to support and funding from the SNI, the University of Basel, the Freiwillige Akademische Gesellschaft and his parents.

And the degree program didn't just enrich his subject knowledge. "I have made many good friends," he comments. His work on the executive board of the Association of Nanoscience Students at the University of Basel has certainly helped him to establish numerous contacts and view his time as a student in such a positive light.

We congratulate Daniel on his excellent and fascinating master's thesis and wish him all the best for the future!



Daniel succeeded in detecting calcifications in the brains of ageing mice. (Image: Daniel Stähli)

"We have been thoroughly impressed by Daniel's passion and dedication to science and his aptitude for experimental research. We would have loved to keep him longer."

Professor Tony Wyss-Coray,
Stanford University (Palo Alto, Kalifornien, USA)

Creative solution
SmallTalk on Zoom

The Swiss Nanoscience Institute's first ever virtual conference was held on May 13. As in previous years, students from the nanoscience program organized the "SmallTalk" conference, in which they reported on two block courses they had attended. However, as the customary large-scale event at the Center for Pharmaceutical Sciences was out of the question this year, "SmallTalk" went virtual instead.

Seven nanoscience students at the University of Basel are currently approaching the end of their bachelor's degree program. Over the last year, they have attended eight different block courses, providing them with a glimpse into the work being done by various research groups. Each year, the students conclude this exciting period in their studies by organizing the "SmallTalk" one-day conference, in which they give a talk on one of the block courses they attended and present a poster on another. The presentations are assessed by some of the researchers offering the block courses.

The event, which is open to anyone interested in attending, is normally held at the Center for Pharmaceutical Sciences. That was not an option this year, however, and the only way for "SmallTalk" to take place at all was as a virtual conference.

Accordingly, on May 13, the seven speakers and seven assessors logged into a Zoom meeting followed by a poster session. The presentations covered topics including various applications of lithography, spectroscopy, atomic force and scanning electron microscopy, interference experiments, ultracold atoms and circuit elements inspired by nerve cells.

"Everything went very well, and we were treated to some exciting and varied presentations," says Professor Wolfgang Meier, head of the nanoscience program, reporting on the SNI's first virtual conference. "During a small apero-to-go, we presented the prizes for best talk and best poster to Timon Baltisberger and Dominik Lüthi in person, and caught up on some discussions.""

Program coordinator Dr. Anja Car is equally positive about the event: "I especially liked the way in which the students made the most of the online platform. Timon Baltisberger, for instance, gave us a striking demonstration of something that is possible in quantum systems but not in the macro world we inhabit." At the start of his talk, it looked like Timon was both giving a presentation and fetching a cup of tea at the same time – an allusion to the phenomenon of superposition, whereby a quantum system can exist in multiple states at once.

In June, Wolfgang Meier (left) and Christian Schönenberger (right) had the opportunity to personally award the prize for best poster to Dominik Lüthi, and the prize for best talk to Timon Baltisberger.

Swiss Nanotechnology PhD Award

Five awards for young scientists

Katharina Kaiser (IBM), Claire Meyer (University of Basel), Shantanu Mishra (Empa), Kazuhiro Morimoto (EPFL) and Daniel Najer (University of Basel) are the winners of this year`s Swiss Nanotechnology PhD Award. The five young scientists impressed the interdisciplinary award committee with their outstanding publications.

Each year, the Swiss Micro & Nanotechnology Network (Swiss MNT Network) presents the Swiss Nanotechnology PhD Award to five doctoral students who have published excellent peer-reviewed papers in the past year. Five Swiss companies donate the prize money of 2,000 Swiss francs each and usually present the prizes at the Swiss NanoConvention, which was scheduled to take place in Basel this year.

Like so many events, this year's PhD Award is somewhat different. The SNC 2020 in Basel has been postponed to 2021, so the 2020 winners will not receive their prizes until the SNC 2021 in Basel. However, that doesn't stop us from reporting on the work of these five young scientists selected by the interdisciplinary award committee comprising members of six different Swiss research institutions.

Diverse and convincing

Katharina Kaiser was behind the research that led to the award-winning publication in Science, working in the group led by Dr. Leo Gross at the IBM Research Center in Rüschlikon. She created a cyclic carbon molecule of 18 carbon atoms by atomic manipulation. She started with precursor molecules, for which she used a combined scanning tunneling/atomic force microscope to split off masking groups. Examination of the new molecule with a high-resolution atomic force microscope revealed that the novel carbon ring is made up of alternating single and triple bonds. The prize awarded to Katharina Kaiser is sponsored by the High-tech Zentrum Aargau.

Link to original paper

Claire Meyer, who is supervised by Professor Cornelia Palivan (University of Basel), won over the jury with a publication in Small. Claire Meyer is working on novel biomedical systems in which synthetic nanocompartments are combined with natural biomolecules. In the award-winning publication, she showed that the combination of nanocompartments with natural enzymes and imaging compounds functions in vitro, allowing the therapeutic enzyme to remain effective while simultaneously enabling controlled imaging. Claire Meyer's prize is sponsored by BASF.

Link to original paper

Dr. Shantanu Mishra, who works in the group led by Professor Roman Fasel, was selected for the PhD Award for a publication in Nature Nanotechnology. Shantanu Mishra synthesized atomically precise carbon nanostructures such as triangular graphene flakes, rhombus-shaped zigzag nanographenes and bowtie-shaped nanographenes, and has demonstrated that these carbon-based materials can exhibit robust magnetism well beyond the thermodynamic threshold. In the award-winning publication, Shantanu Mishra shows how on-surface synthesis can be ideally combined with scanning probe microscopy/spectroscopy to unambiguously detect magnetism in carbon nanomaterials. His work paves the way for production of new magnetic materials with technological relevance. The prize is sponsored by the companies Zeiss and Gloor.

Link to original paper

Kazuhiro Morimoto has developed a megapixel camera based on single-photon avalanche diodes (SPAD) working at AQUALab, the laboratory of Professor Edoardo Charbon (EPFL). The results are described in a paper published in Optica. The camera can operate in intensity and time-gated mode with a shutter speed of 3.8 nanoseconds and a readout speed of 24,000 frames per second. It delivers images and three-dimensional scenes with an accuracy of a few millimeters and a resolution of 1000 x 1024 pixels, and will contribute to numerous interesting applications in metrology, microscopy and LiDAR (light detection and ranging, a method similar to radar). Kazuhiro Morimoto's prize is sponsored by the company Sensirion.

Link to original paper

Dr. Daniel Najer, a member of the group led by Professor Richard Warburton (University of Basel) has shown in a publication in Nature that an efficient quantum-mechanical light-matter interface can be created using a microscopic cavity. Within this cavity, a single photon is emitted and absorbed up to 10 times by an artificial atom (a semiconductor quantum dot). The work opens up new possibilities for quantum technology. Daniel Najer's prize is awarded by the company Bühler.

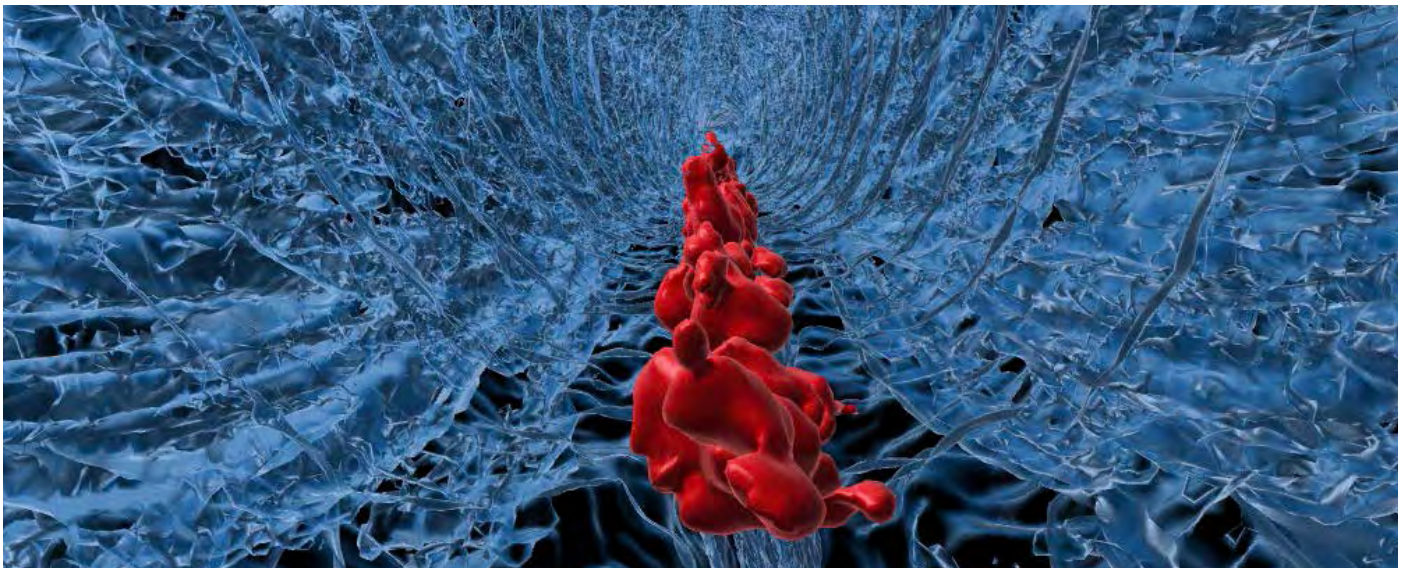
Link to original paper

"We congratulate all prize winners on their outstanding publications. We look forward to the award ceremony next year at the SNC 2021 in Basel from June 24 to 25."

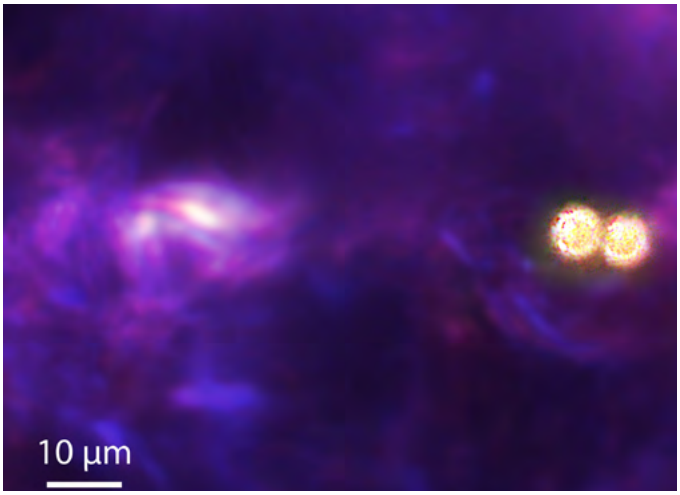
Professor Christian Schönenberger, SNI Director

SNC Image Award
Fascinating images

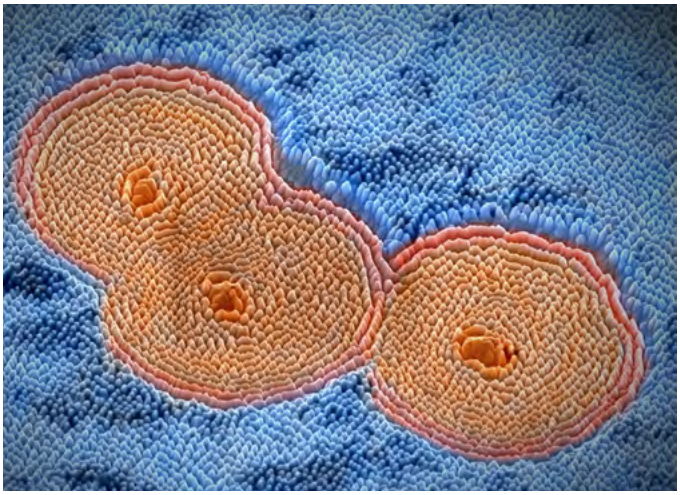
The postponement of the SNC did not stop us from announcing the results of the latest SNC Image Award. The following fascinating images of the nano world are this year's winners:



First prize: Accumulated superparamagnetic iron oxide nanoparticles in a zebrafish embryo, by Jan Stephan Bolten of the Department of Pharmaceutical Sciences, University of Basel



Second prize: Self-assembled cadmium selenide/cadmium sulfide semiconductor nanocrystals, by Darius Urbonas, IBM Research GmbH



Third prize: Surface structure of a rhodium crystal, by Fabien Sanchez, Department of Physics & Daniel Mathys, Nano Imaging Lab, University of Basel

«Many thanks for participation and congratulations to the winners!»

Further information about the SNC Image Award

Hydronics
An interdisciplinary investigation of charge and heat transport

The Swiss National Science Foundation recently pledged 2.7 million Swiss francs in funding for the interdisciplinary Sinergia project “Hydronics”. The project is led by Professor Ilaria Zardo of the Department of Physics, and brings together an interdisciplinary team of researchers from the University of Basel, EPFL, Empa and IBM to study charge and heat transport, and explore new ways of controlling electrical and thermal currents.

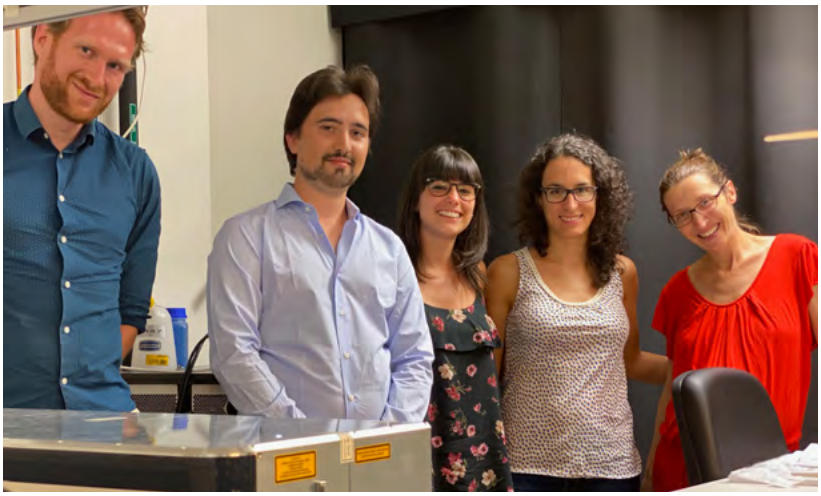
Differences in thermal propagation

Electronic systems are growing smaller and more powerful all the time. One drawback of this kind of miniaturization is heat build-up in electronic components. Accordingly, for the computer and electronics industry it is increasingly important to understand the phenomenon of charge and heat transport, and find ways to control it.

Heat in electronic components is produced by mechanical oscillations known as phonons. In a three-dimensional solid, these oscillations habitually spread in a diffuse manner. In two-dimensional materials, however, their propagation closely resembles that of currents in liquids under certain conditions. Accordingly, experts refer to this process as hydrodynamic transport, which exhibits properties clearly distinguishing it from diffuse transport. For example, in hydrodynamic transport a thermal impulse propagates through the medium in a manner similar to a shockwave, with no significant damping, whereas diffuse transport involves substantial losses.

In pursuit of selective control

The ability to effectively harness the hydrodynamic transport regime would pave the way for materials in which the propagation of phonons could be selectively controlled. This would make it possible to design materials that emit heat very rapidly, thereby minimizing heat build-up. The same principle could be used to maintain thermal differences for as long as possible in order to exploit them for power generation purposes.



The team of Ilaria Zardo (right) participates in the Sinergia project «Hydronics».

Interdisciplinary collaboration

Such an undertaking requires extensive knowledge in the fields of materials science and equipment engineering, along with experience in computer-assisted transport models and the development of experimental protocols. Consequently, some of Switzerland’s leading researchers in these fields have decided to work together to research the field of hydrodynamic heat and charge transport. Over the next four years, the groups led by Professor Michel Calame (Empa), Professor Nicola Marzari (EPFL)

Further information

Web page Zardo team
https://nanophononics.physik.unibas.ch

Sinergia projects
http://www.snf.ch/de/foerderung/programme/sinergia/Seiten/default.aspx

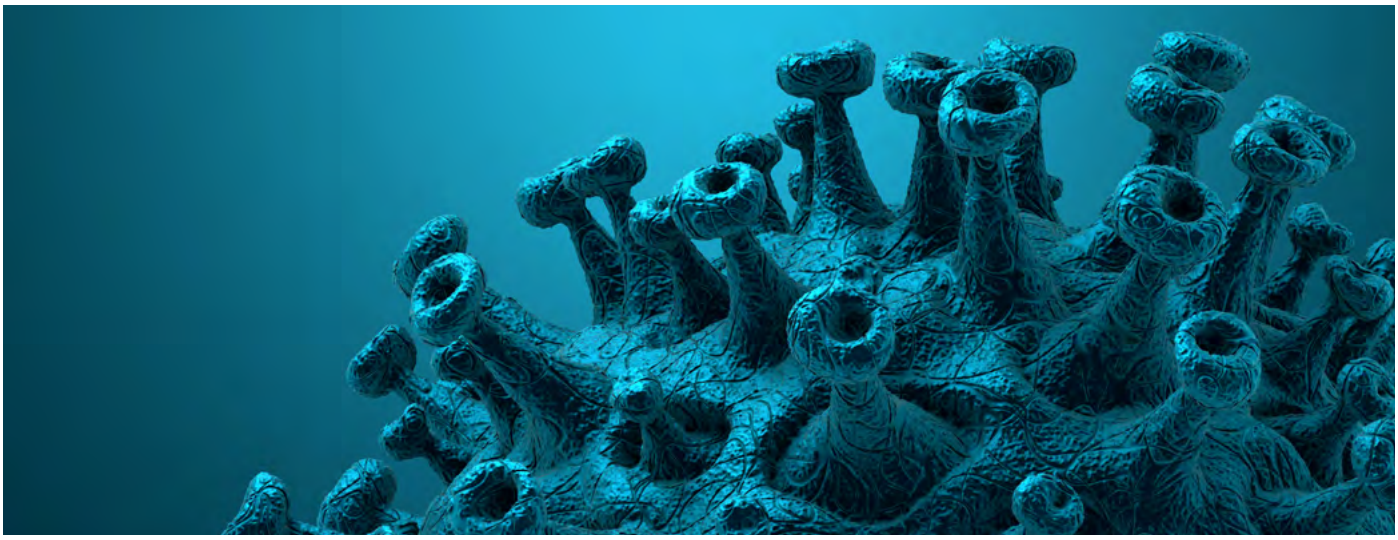
and Dr. Bernd Gostmann (IBM) will work alongside Professor Zardo's team in pursuit of the shared goal of controlling and conducting both electrical and thermal currents with much greater efficiency than presently possible.

Firstly, the researchers plan to develop theoretical models to describe this form of hydrodynamic transport. These models will be used to predict key variables and phenomena that can subsequently be confirmed experimentally. This will involve designing suitable experiments to demonstrate hydrodynamic transport effects in heat and charge transport. Moreover, the researchers expect to be able to predict hydrodynamic transport phenomena in known 2D and 3D materials with a view to optimizing them by structuring the materials. Finally, microscale devices operating on the basis of hydrodynamic transport effects will be created to demonstrate the operating principle.

In line with the requirements for Sinergia projects, the Hydronics project will involve close collaboration between various groups to conduct groundbreaking research. While basic research will play a major role in the early stages of the project, the participating researchers will also work on applied aspects, particularly in the fields of microfabrication and equipment engineering. Sub-projects will involve doctoral and postdoctoral candidates, equipping them with important know-how in preparation for careers in research or industry.

Multifaceted and up-to-date
Coronavirus research in the SNI network

The SARS-CoV-2 coronavirus has been occupying all of our minds over the past weeks and months. No one imagined that the world could change so radically in such a short space of time. At the start of the pandemic, we didn't know much about the virus. Thanks to the tremendous dedication of researchers around the world, we now understand much more about how the virus spreads, how we can detect it, what the consequences of infection are and how we can keep infection rates as low as possible. Members of the SNI network are also involved in research on the virus – some through projects they initiated themselves, and others through experiments that began earlier but whose results can be applied to coronavirus research. Here we provide a brief overview of some of the projects.



Members of the SNI network are involved in research on the novel SARS-CoV-2 virus. (Image: Shutterstock)

New approaches in diagnostics

Rapid detection of the novel coronavirus SARS-CoV-2 is a significant part of the fight. Only if we know quickly whether a patient is infected, can the massive spread be reduced by measures such as quarantine. Information about whether someone has already been exposed to the virus and whether the body has produced specific antibodies that protect against reinfection is also important. In order to expand testing capabilities, several research groups from the SNI network are working on the development of new test systems.

Detecting the virus in different media

Together with their interdisciplinary teams, Professor Sai Reddy (Department of Biosystems Science and Engineering, ETH Zurich in Basel, D-BSSE) and Professor Michael Nash (Department of Chemistry, University of Basel and D-BSSE) aim to develop a new diagnostic test for COVID-19 infections.

This new test is based on high-throughput sequencing of SARS-CoV-2 and utilizes an approach called "molecular barcoding" to test many patients in parallel. Using this method, about 5,000 individual patient samples could be tested for SARS-CoV-2 at once. The researchers are also developing a high-throughput serological platform for detecting antibodies against SARS-CoV-2. Patients who have survived an infection with the virus and have these antibodies in their blood are likely to be immune to new infections for a certain period of time. Professor Reddy is leading this project, which is funded by the Botnar Research Center for Child Health (BRCCH).

Dr. Sören Fricke (CSEM Muttenz) is also involved in a BRCCH-funded diagnostics project. He is working in a team led by Professor Daniel Paris (Swiss Tropical and Public Health Institute, TPH). Their aim is to develop a simple, low-cost assay for detecting SARS-CoV-2 antibodies in saliva.

In a first step, the team is currently proving that the saliva contains a sufficiently high concentration of antibodies. They will then begin developing a lateral flow assay, which works like a pregnancy test. CSEM will contribute to the project with developments in the area of cellulose pads, sample preparation and visuals, in order to optimize the test for saliva and for readability on smartphones.

The groups led by Professors Ernst Meyer and Christoph Gerber (both Department of Physics, University of Basel) are investigating whether a mechanical sensor for the ultrasensitive detection of coronavirus could be used in public spaces and vehicles. Their approach involves applying short RNA fragments, which are complementary to specific RNA segments of the virus, to a cantilever. If these RNA fragments come into contact with virus RNA, it causes a hybridization reaction and creates mechanical stress. This bends the mechanical sensor, and the bending can be detected by an optical detection system. The method could be used to identify even very low virus concentrations.

Reaching the goal with a microfluidic system

Various groups in the SNI network are working on microfluidic systems and are investigating their use in COVID-19 research.

Thomas Mortelmans, a doctoral student at the SNI PhD School at PSI, is writing his doctoral dissertation on the development of a microfluidic system that can be used to sort cell organelles and other biological nanoobjects based on their size. He is now investigating whether the fluidic system can also be used for antibody testing. Functionalized nano- or microparticles (beads) bind specifically to the antibodies. These can then be purified and identified.

Dr. Yasin Ekinci, Dr. Celestino Padeste, Dr. Xiaodan Li (all PSI) and Dr. Thomas Braun (Biozentrum, University of Basel) are supervising Mortelmans' doctoral dissertation.

Further information:

Prof. Sai Reddy
https://bsse.ethz.ch/lsi/the-lab/People/STR.html

Prof. Michael Nash
https://bsse.ethz.ch/department/people/detail-person.MjI4ODcx.TGIzdC8yNjY5LDEwNjI4NTM-0MDk=.html

https://nash.chemie.unibas.ch/en/home/

BRCCH
https://brc.ch

CSEM
https://www.csem.ch/Home

COVID-19 research CSEM
https://www.csem.ch/Page.aspx?pid=155080

Prof. Ernst Meyer
https://nanolino.unibas.ch

Prof. Christoph Gerber
https://www.physik.unibas.ch/personen/prof-gerber.html

SNI PhD student Thomas Mortelmans is investigating whether a microfluidic system that can be used to sort cell organelles and other nanoscale biological objects by size can also be applied to antibody testing. (Image: T. Mortelmans)

Further information:

Dr. Ysin Ekinci
https://www.psi.ch/en/lmn/people/yasin-ekinci

Dr. Celesto Padeste
https://www.psi.ch/en/mgg/people/celestino-padeste

Dr. Xiaodon Li
https://www.psi.ch/en/lbr/people/xiaodan-li

Dr. Thomas Braun
https://www.c-cina.org/people/team/thomas-braun/

Thomas Mortelmans
https://nanoscience.ch/de/forschung/phd-programm/phd-projekte/2018-begonnen/

COVID-19 research at PSI
https://www.psi.ch/de/forschung-zu-covid-19

Treating COVID-19

Infection with SARS-CoV-2 causes the new respiratory disease COVID-19. According to the Robert Koch Institute, the disease can take different courses that vary enormously – from asymptomatic cases to severe pneumonia accompanied by respiratory failure. According to data from the German reporting system, about 17% of the cases reported in Germany by July 2020 required hospital treatment (source). In Switzerland and Lichtenstein the hospitalisation rate was around 12% (source).

Severe pneumonia causes an acute undersupply of oxygen, and the patient requires mechanical ventilation. The ventilator pushes oxygen into the lungs, and from there it enters the blood.

Dr. Sören Fricke (CSEM Muttenz) is involved in a BRCCH-funded project led by Professor Thomas Erb (University Children's Hospital Basel, UKBB) that is seeking to make ventilation safer. The researchers are planning to integrate an innovative pressure sensor into low-cost ventilators. In doing so, they hope to improve ventilation and help overcome the global shortage of ventilators. Erb und Fricke are building on a joint project in which CSEM integrated a flexible, microstructured pressure sensor into a tube. The sensor measures the pressure closer to the respiratory organs, which makes it easier to avoid the sensitive tissue being damaged by the mechanical ventilation.

Production protocol for in-demand drug

A team working with Professor Jörg Huwyler and Dr. Tomaz Einfalt at the University of Basel's Pharmazentrum has developed, produced and characterized a

Further information:

Prof. Jörg Huwyler
https://pharma.unibas.ch/de/personen/joerg-huwyler-1475/

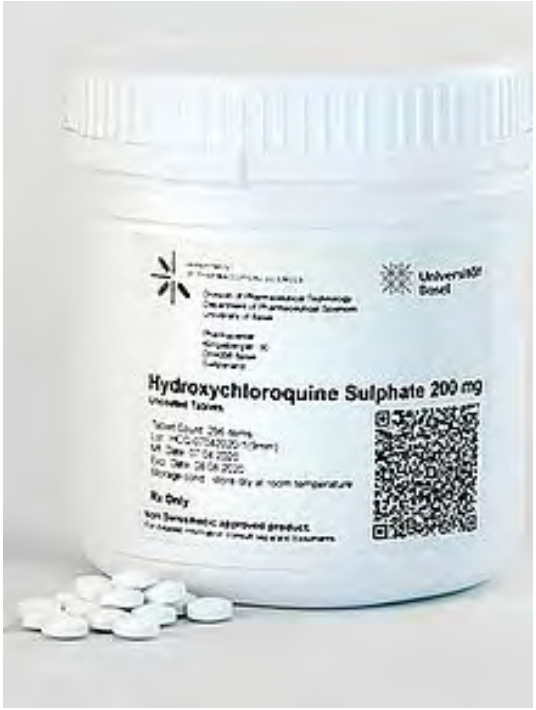
Media release Hydroxychloroquin production
https://www.unibas.ch/de/Aktuell/News/Uni-Research/Moegliches-Corona-Medikament-Uni-Pharmazeuten-stellen-ein-Generikum-her.html

COVID-19 research projects University of Basel
https://www.unibas.ch/de/Aktuell/Coronavirus/Covid-19-Forschungsprojekte.html

generic formulation of the drug hydroxychloroquine (HCQ). HCQ is a quinoline derivative used to treat malaria and rheumatic diseases. Recent reports that HCQ could be effective against SARS-CoV-2 have led to a rapid increase in global demand for the drug[1]. As a result, patients with rheumatic diseases being treated with HCQ were facing acute shortages of their medication. The scientists working at the Pharmazentrum hope that the published production protocol will help ensure that sufficient quantities of HCQ tablets can be produced.

Learning to understand the new virus

Overall, it is important that we gain a better understanding of SARS-CoV-2 so that we can effectively protect ourselves against infection and effectively treat infections.



Generic medication from the research lab: Basel researchers could produce tablets for up to 20,000 patients. (Image: University of Basel, Basil Huwyler)

1 A research group from the University of Basel and University Hospital in Basel recently published that the concentration of hydroxychloroquine in the lungs of Covid-19 patients is not sufficient to fight the virus (media release).

InterAx Biotech AG, a startup from PSI and a long-term partner in the Nano Argovia Program, is working with the Hospital del Mar Medical Research Institute (IMIM) in Barcelona on identifying antiviral active substances. The researchers are looking for potential antiviral compounds in a virtual 3D-structure database using specific computational algorithms. They will then use an assay with a SARS-CoV-2 pseudovirus to test whether the compounds can prevent the virus entering the cells. The team is investigating two different ways of attacking the virus.

The group led by Professor Thomas Jung (Department of Physics, University of Basel and PSI) is planning to investigate whether the composition or consistency of a medium such as saliva or tears that contains the virus can prolong the survival of the virus. The current literature is contradictory. Some papers report that the virus can remain infectious on surfaces for up to three weeks.

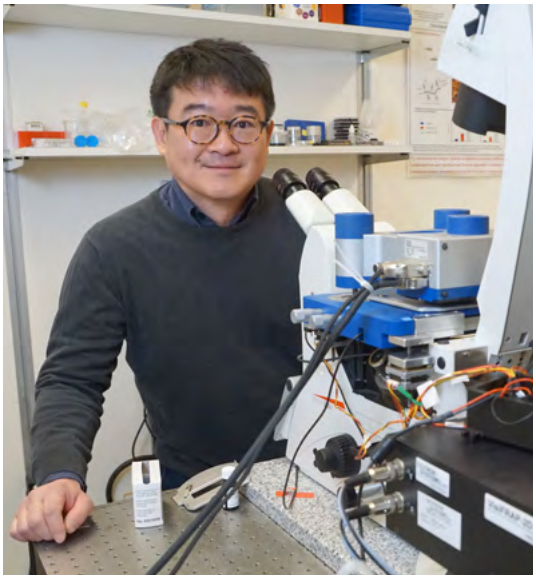
Jung's group is currently seeking partners to produce the SARS-CoV-2 spike protein and "dummy" viruses from artificial vesicles. The "dummy" viruses will be embedded in a matrix modeled on mucous. The researchers will then use various methods to investigate how different types of disinfection (UV light, alcohol, vinegar) and climate factors affect the destruction of the vesicles and the denaturation of the spike proteins. The work should help with planning effective and cost-efficient disinfection campaigns.

The group of Argovia Professor Roderick Lim is also interested in understanding SARS-CoV-2. The team has been working for many years on the transport of molecules into and out of the cell nucleus, which is regulated by nuclear pore complexes in the membrane of the cell nucleus.

Based on findings from SARS-CoV-1 studies, various viral proteins and proteases from SARS-CoV-2 are suspected of influencing the function of the nuclear pore

complexes. It is not currently known whether and how SARS-CoV-2 damages these selective channels to disrupt the transport of vital proteins into the cell nucleus.

Using tests with antiviral compounds, the scientists plan to investigate whether it is possible to prevent potential damage that SARS-CoV-2 might inflict on the nuclear pore complexes and to sustain transport through the nuclear membrane.



Argovia Professor Roderick Lim hopes to find out whether – and how – SARS-CoV-2 interferes with the process of nuclear transport.

SNI doctoral student Stefano di Leone is working on a project that will improve our understanding of how viruses can penetrate membranes. Biological membranes are formed from lipids and are typically between 3 and 5 nm thick.

Artificial planar membranes that spontaneously form from amphiphilic block copolymers in aqueous environments are a very good way of examining transport processes through the membrane. The artificial membranes are between 5 and 25 nm in diameter and are more stable than their natural counterparts.

When the amphiphilic block copolymers are mixed with lipids, membranes form with specific domains of polymers and lipids. Functional proteins can then be very immobilized in a highly targeted manner on either the lipid or the polymer domain. These model membranes can be used to investigate how the virus attaches itself to the host. It is also possible to test whether proteins that induce a specific reaction from the virus can be integrated into the membrane.

Di Leone's work is being supervised by Professor Wolfgang Meier (Department of Chemistry, University of Basel) and Professor Uwe Pieles (FHNW School of Life Sciences).

More information about research team of:

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

Prof. Wolfgang Meier
https://meier.chemie.unibas.ch/en/home/

Stefano Di Leone
https://nanoscience.ch/de/forschung/phd-programm/phd-projekte/2017-begonnen/#&gid=4&pid=1

Prof. Uwe Pieles
https://www.fhnw.ch/de/forschung-und-dienstleistungen/lifesciences/chemie-und-bioanalytik/nanomaterialien-und-oberflaechen

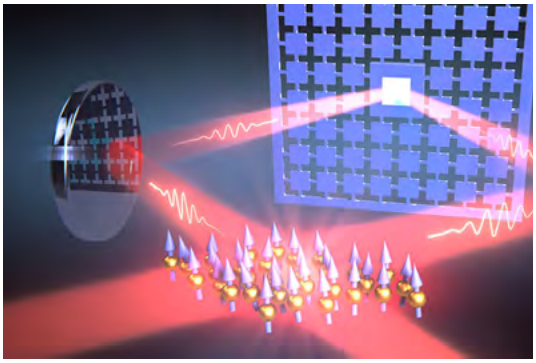
"Our knowledge about SARS-CoV-2 will continue to grow in the coming weeks and months. We are very much looking forward to seeing the results that will come out of global studies and those being conducted within the SNI network."

Professor Christian Schönenberger, SNI Director

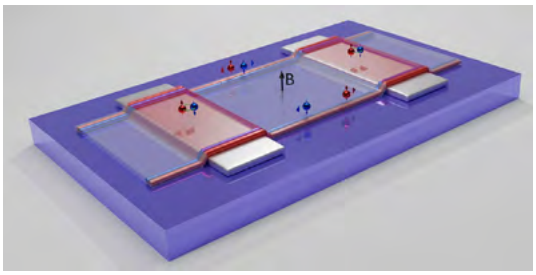
News from the SNI network

Laser loop couples quantum systems over a distance

For the first time, researchers have succeeded in creating strong coupling between quantum systems over a greater distance. They accomplished this with a novel method in which a laser loop connects the systems, enabling nearly lossless exchange of information and strong interaction between them. In the scientific journal Science, the physicists from the University of Basel and University of Hannover reported that the new method opens up new possibilities in quantum networks and quantum sensor technology. Media release



A loop of laser light connects the oscillations of a nanomechanical membrane (back) and the spin of a cloud of atoms (front). (Illustration: Department of Physics, University of Basel)



Schematic diagram of the experimental setup: An atomically thin layer of tungsten ditelluride is located between two contacts (in silver). Current only flows through the material in very narrow channels at the outer edges. (Image: Department of Physics, University of Basel)

Lossless conduction at the edges

Atomically thin layers of the semimetal tungsten ditelluride conduct electricity losslessly along narrow, one-dimensional channels at the crystal edges. The material is therefore a second-order topological insulator. By obtaining experimental proof of this behavior, physicists from the University of Basel have expanded the pool of candidate materials for topological superconductivity. The findings have been published in the journal Nano Letters. Media release

"Saubere Sache" exhibition opens

On June 9, the «Saubere Sache» special exhibition opened its doors at the Burghalde Museum in Lenzburg. The exhibition is devoted to the fascinating and highly topical world of soap. Further Information

The team of Artidis, a spin-off from the University of Basel. (Photo: Artidis)

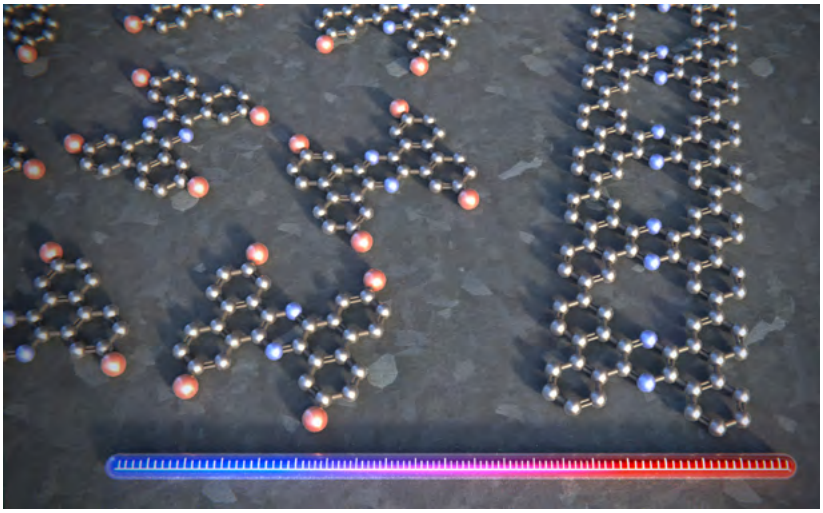
Breast Cancer Diagnostics: Spin-off Artidis announces successful clinical trial

The company Artidis, a University of Basel spin-off, has announced that it developed a test procedure that can detect breast cancer with a very high sensitivity. This is demonstrated by a clinical trial that investigated whether a nanomechanical biomarker of tissue samples is suitable for the diagnosis of breast cancer. Media release

Experiments for the holidays

The summer holidays are just around the corner or may have already begun. But this year, many families will have to change their holiday plans. To avoid boredom at home, ideas for joint activities are needed that will inspire young and old alike. Experiments with household items suitable even for kindergarten and primary school children are a great option.
Media release

The SNI team demonstrates a selection of fun experiments that everyone can learn from.



The individual building blocks are heated on a silver surface in order to synthesize a porous graphene ribbon that exhibits semiconducting properties and a ladder-like structure. In each rung of the ladder, two carbon atoms have been replaced with nitrogen atoms (blue). (Illustration: Departement of Physics, University of Basel)

Porous nitrogen-doped graphene ribbons for future electronics

A team of physicists and chemists has produced the first porous graphene ribbons in which specific carbon atoms in the crystal lattice are replaced with nitrogen atoms. These ribbons have semiconducting properties that make them attractive for applications in electronics and quantum computing, as reported by researchers from the Universities of Basel, Bern, Lancaster and Warwick in the Journal of the American Chemical Society. Media release

Tiny fish under a giant camera

Metal-based nanoparticles are a promising tool in medicine – as a contrast agent, transporter of active substances, or to thermally kill tumor cells. Up to now, it has been hardly possible to study their distribution inside an organism. Researchers at the University of Basel have used a three-dimensional imaging method to take high-resolution captures inside zebrafish embryos. Media release

Using microtomography in phase contrast mode, researchers at the University of Basel succeeded in taking high-resolution, three-dimensional images of zebrafish embryos in which the distribution of nanoparticles (red) is visible. Also in red and easy to distinguish because of their high density are the lens of the eye and the otoliths in the inner ear – that is, tiny pieces of calcium carbonate in the vestibular system (Image: University of Basel, Jan Bolten)

ELDICO Scientific scores a hat trick and receives further investor funds

The award-winning Swiss deep-tech start-up ELDICO Scientific beat its Venture Kick competitors for the third time in a row and wins 150,000 Swiss francs. Media release

Nano Argovia program

Technology transfer in Northwestern Switzerland

The Nano Argovia program supports innovation and technology transfer for companies in Northwestern Switzerland. It bridges the gap between basic scientific research conducted at the SNI and its industrial applications.

The deadline for submissions to the Nano Argovia applied research program is September 30.

Further Informationen

Rules and forms

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