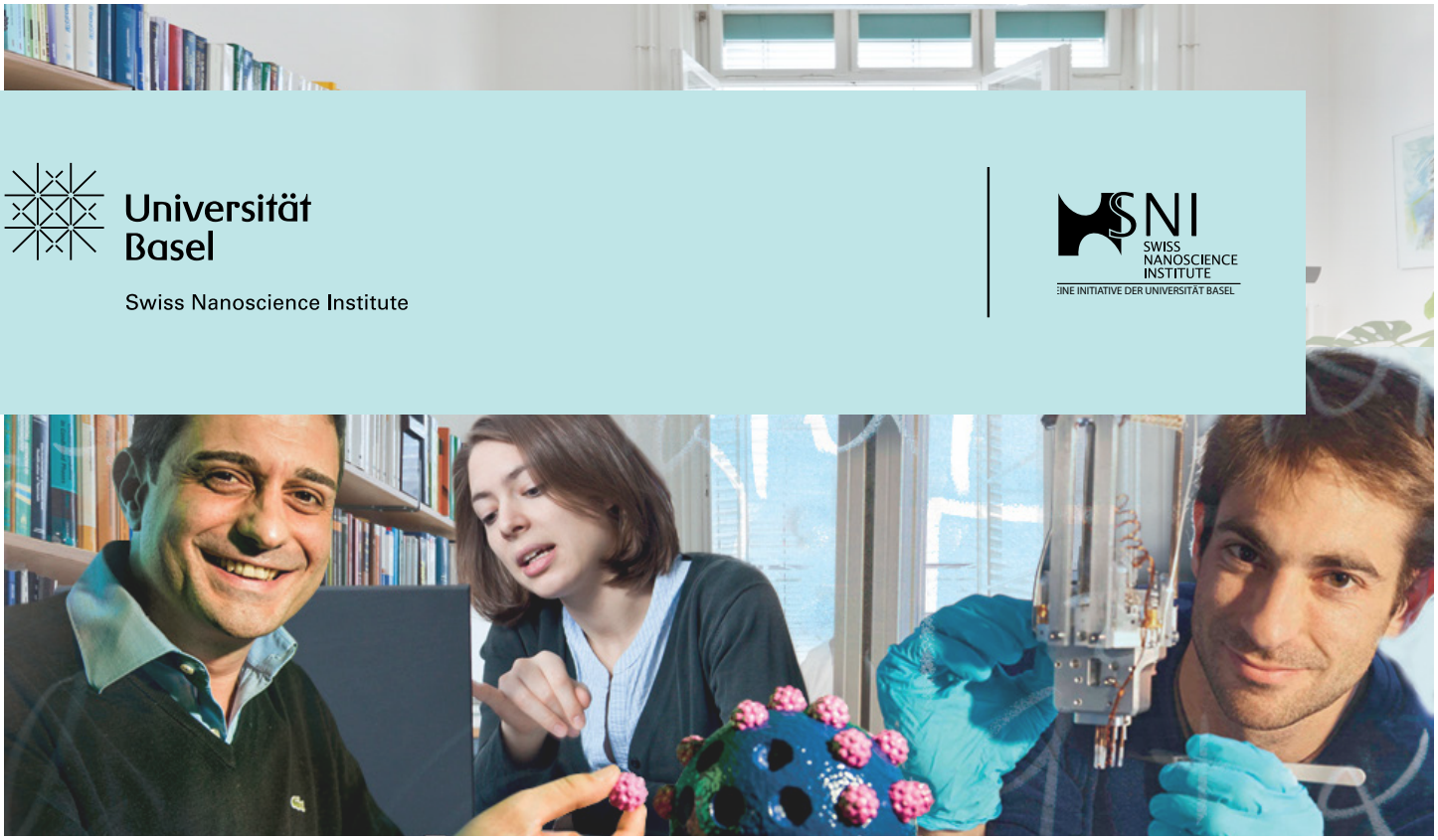


Universität Basel

Swiss Nanoscience Institute

SNI SWISS NANOSCIENCE INSTITUTE
EINE INITIATIVE DER UNIVERSITÄT BASEL

SNI update October 2015

Words from the Editor

Dear colleagues

Summer has taken its leave and the semester has begun. We have already welcomed many new students to our university, which this year is celebrating its 555th anniversary. The Uni-Nacht on September 18 showed the public just how young and dynamic our university remains. The SNI was also involved in this event and engaged with children and young people in particular, offering presentations that taught them new things in a playful way, a laser labyrinth to test their dexterity, and a creative workshop where they could craft a variety of things relating to the topic of light.

A number of young people have also visited the SNI over the past few weeks to find out more about nanosciences. In Kerstin Beyer-Hans, we once again have an expert contact for various different types of visitors. Our services are being well received by school classes and industry representatives wishing to visit the SNI.

Peter Rickhaus was also involved in some of these visits. He has just completed his doctorate on graphene in my group and is very adept at talking about his research to a mixed audience. I was delighted to see him receive the Swiss Physical Society prize for his research in September. You can read about him and his research in more detail in the cover story and portrait in this issue of SNI update. Further, SNI doctoral students have excelled this summer, working with two nano students to organize INASCON 2015. I would like to congratulate them all on this successful event, which has certainly boosted Basel's positive reputation as a center for nanoscience.

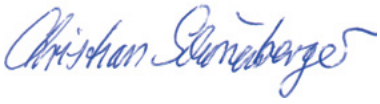
I was also pleased to see a number of press releases and uni news items reporting on the academic successes of SNI members in the past few weeks. As always, you will find an overview of these achievements at the end of this SNI update.

Good photos and high-quality images are always important, both for the press and for our internal communication materials, which is why we are launching another "Best Nano Image

Award". Send your best pictures from the nano world to Christel Möller (c.moeller@unibas.ch) and you could be one of the three winners of CHF 300 in prize money.

I am already looking forward to helping select the best photos.

Kind regards

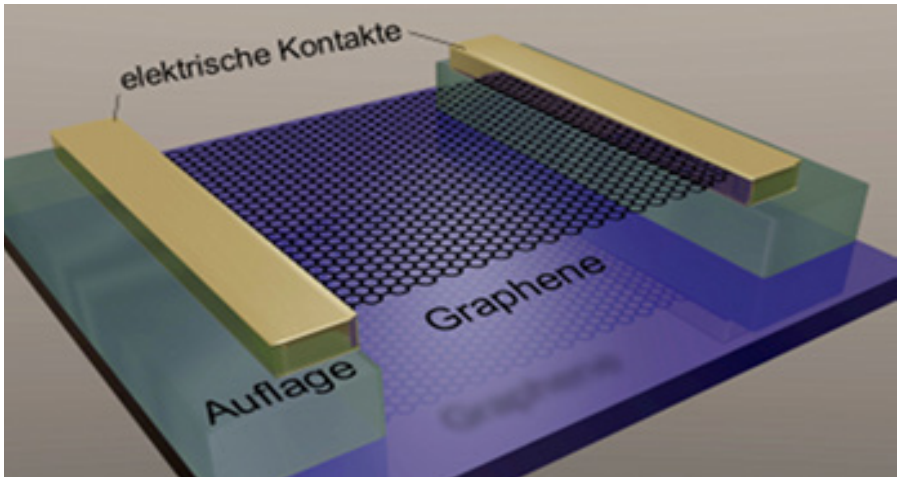


Director Swiss Nanoscience Institute, University of Basel

Cover Story

Electrons Moving Through Graphene

Googling "graphene" returns almost 11 million hits. Hundreds of research groups around the world focus on this special material, which has just two dimensions. One of these research groups is led by Professor Christian Schönenberger at Basel University's Department of Physics. His research is supported by the European "Graphene Flagship" and the Swiss Nanoscience Institute, and focuses primarily on the electrical properties of graphene.



The two-dimensional graphene can be stretched freely between two supports.

Ultra-thin with fascinating properties

Graphene comprises a single layer of carbon atoms in a honeycomb structure. It is the first truly two-dimensional material available to researchers. Graphene is transparent, harder than diamonds and 200 times stronger than steel, yet flexible and significantly better at conducting electricity than copper. However, working with graphene presents researchers with several challenges. Nobel Prize winners Geim and Novoselov may have found a comparatively simple method of first producing graphene, but much more complex processing is required to investigate its electrical properties.

New production technique facilitates studies

To achieve this, scientists in Basel have developed a method to stretch graphene freely between two supports and clean it. Their work, which was published in Nature Communications in 2013, describes how micro- and nano-production techniques can be used to stretch a layer of graphene several micrometers in length between silicon supports. By using this technique, researchers avoid disruptive contact with the substrate. They also developed a subsequent cleaning step in which a strong current runs through the graphene layer. This heats up the material and removes contaminations from the surface.

This new processing technique was developed primarily by Peter Rickhaus, who completed his doctorate in Professor Schönenberger's team in September. His measurements showed that the new technique improved the conductivity of graphene enormously. In a similar way to light, the electrons moved through the cleaned, two-dimensional graphene layer almost without loss – without dispersion or resistance –

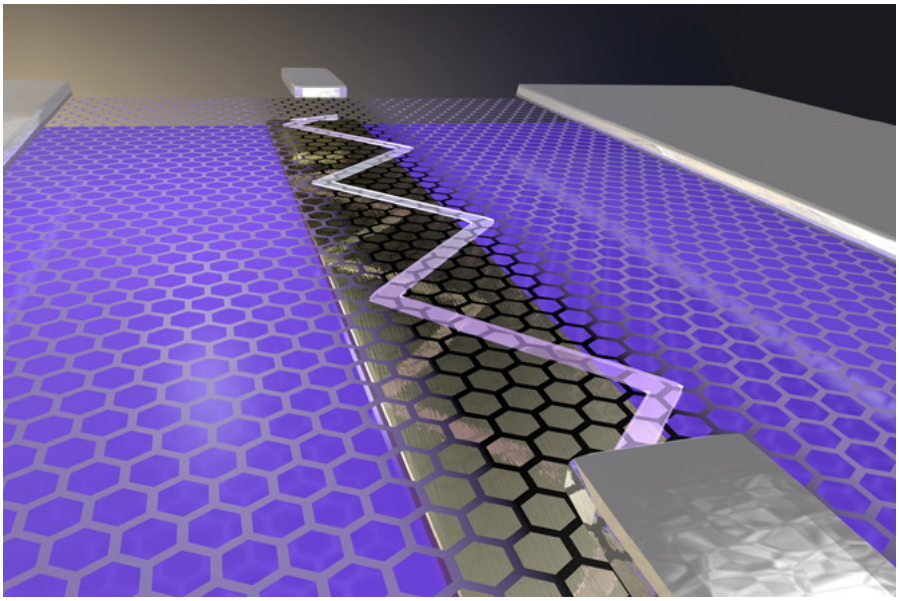
at one three-hundredth of the speed of light.

Following a defined path

In further experiments, the team around Schönenberger and Rickhaus was able to show that electrons can be conducted through graphene not only without loss, but on a predefined trajectory. When an electrical field and a magnetic field are combined, the electrons move forward in curved lines. This line bends alternately from left to right, which can be explained by the sequence of a positive and negative mass. This electron guiding can be switched on and off, and is therefore suitable as a novel nano switch that can be installed in various devices. “The switch can be operated simply by altering the magnetic or electrical field,” says Christian Schönenberger of the results, which were also published in Nature Communications in early 2015.

Flow of electrons similar to that in a glass fiber cable

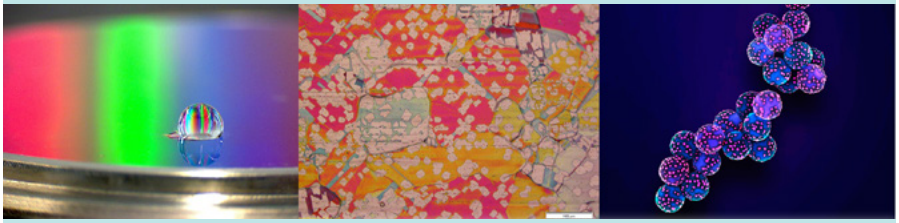
Peter Rickhaus, who recently received a prize from the Swiss Physical Society for this academic work, has in the last month published further findings regarding charge transport in graphene together with Dr. Peter Makk and other colleagues from Professor Schönenberger’s group. In Nanoletters, the researchers show how, in a more advanced set-up, electrons can be conducted through graphene without an external magnetic field. “Under these experimental conditions, the electrons moved via electrical control alone, as in a glass fiber cable. Since we only require an electrical field, this is much easier to achieve and increases the chance of practical application,” comments Christian Schönenberger, explaining these latest results.



In graphene, electrons can move via electrical control as in a glass fiber cable.

Peter Rickhaus completed his doctorate at the end of September, but his colleagues in Christian Schönenberger’s group continue to examine graphene, the “miracle material”, in detail and to explore potential electronic applications.

SNI Nano Image Award 2015



We are looking for the most beautiful images of the nanoworld and will honor the three best pictures with 300 Swiss Francs each.

Don’t miss the chance and participate! Please submit your photos together with a title, a short description, and the scale of the image to c.moeller@unibas.ch until **October 31st, 2015**.

We will present the best pictures on our website and will announce the winners in the next issue of SNI update.

We introduce...

An Excellent and Socially Engaged Researcher

Peter Rickhaus, until recently a doctoral student in Professor Christian Schönenberger's group, received the Metrology prize from the Swiss Physical Society (SPS) in September for his work on electron transport in graphene. However, the 28-year-old physicist is not just interested in the properties of this highly regarded material; he also has three young children and is actively involved in social projects.

First nano, then physics

Peter Rickhaus was born in Bern and grew up in Laufen. His interest in the diversity of natural sciences led him to study nanosciences in Basel. During his Bachelor's studies, he found himself particularly drawn to physics topics and fascinated by lectures on quantum mechanics and electrodynamics. "It was new, substantial, and it fascinated me," Rickhaus recalls. He therefore decided to switch to physics for his Master's. His Master's thesis on superconductors brought him to Christian Schönenberger's group, where he remained for his doctorate. As his successes suggest, this was a very good decision.

Two Nature papers and one SPS award

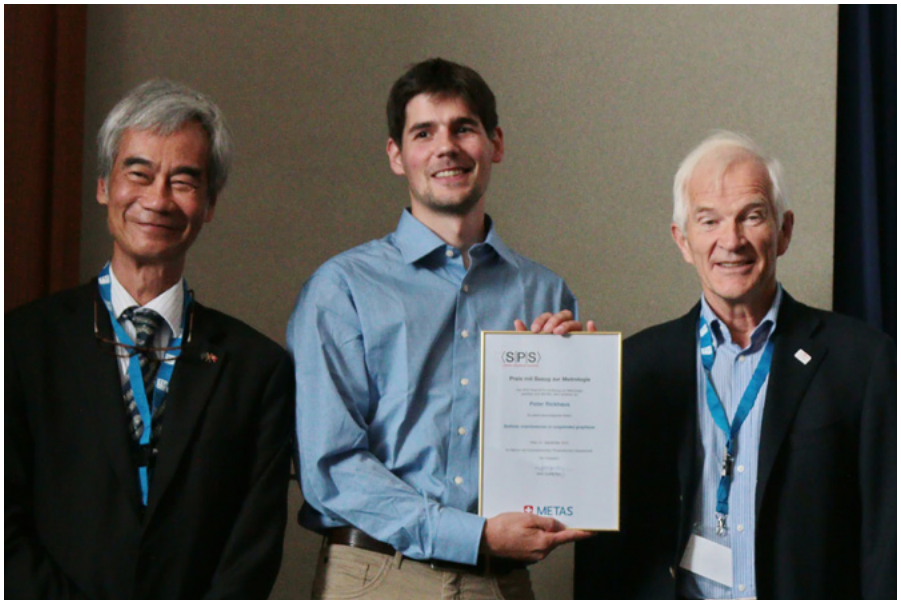
Back in 2013, Nature Communications accepted the first paper written by Peter Rickhaus and his colleagues in which he was cited as the lead author. This publication described a new method of stretching graphene between two supports and cleaning it. The subsequent measurements showed that electrons move within the graphene film without loss. "Ming-Hao Liu's simulations at the University of Regensburg confirmed our measurements exactly," comments Rickhaus. His second Nature Communications paper followed in 2015, in which he and his co-authors demonstrated that the electrons in graphene could be guided along a predefined route. When an electrical field and a magnetic field are combined, the electrons move forward in curved lines. In September, the Swiss Physical Society presented him with its Metrology prize, funded by the Federal Institute of Metrology (METAS), in recognition of this research.

During his Bachelor`s studies, Peter Rickhaus was especially interested in physics topics.

Future still unclear

Peter – who completed his doctorate at the end of September and will remain in the Schönenberger laboratory until the end of the year as a postdoc – is, however, still not certain where his career will take him next. "I'm going to start with a year of community service," he comments in the interview. He will spend the first half of this period assisting refugees with their applications. "I'm looking forward to doing something so different," the 28-year-old says.

What will follow is still unclear. "I might miss the university and research so much that I'll know exactly where I belong." But he is a little skeptical. Although he finds research fascinating, he realizes that an academic career requires a great willingness to make sacrifices. And with three children aged 1, 3, and 5, Peter Rickhaus is not just thinking of himself, but has to plan with his family in mind, too. "Three years here, five years there, another year somewhere else – that's not



In September, Peter Rickhaus received the METAS prize from the Swiss Physical Society (SPS-President Prof. Minh Quang Tran, Peter Rickhaus and Prof. Louis Schlapbach, Chairman of the SPS Award committee (Image: A. Weis, Uni Fribourg)).

something I'd suggest for school-age children," he comments. Options he is currently considering include teaching or working for an NGO.

Defining moments in Paraguay

After finishing high school, Peter Rickhaus spent nine months in Paraguay working in a home for former street children. "I experienced some defining moments there and gained an impression of our planet's global inequalities," he recalls. You can tell that he genuinely wants to do something to counter this injustice. Up to now, his doctorate and family have taken up all his time. However, he seems to be balancing work and family very well. On this subject, he acknowledges the freedom offered by his doctoral supervisor, Christian Schönenberger, and the excellent teamwork within his research group: "I am extremely grateful to my team. As a father, I am the odd one out. When I needed to get my experiments finished, there was always someone willing to help."

Events

Large Crowds Right up to Midnight

On September 18, both young and old congregated in various buildings at the University of Basel until late into the night. To celebrate its 555th anniversary, Switzerland's oldest university invited the public to enjoy the Uni-Nacht.

In the creative workshop of the SNI, children and young people were invited to craft activities relating to the topic of light.

The SNI played its part, too. Together with Peter Reimann from the Department of Physics, Kerstin Beyer-Hans and Christel Möller put together a wide-ranging program of talks, live experiment demonstrations, and activities. The laser labyrinth, which was constructed by Kerstin, Peter, Michael Steinacher, Heinz Breitenstein, and the technique teams was a particular success. Even as midnight approached, the queue showed no sign of shortening. And the creative workshop, which offered children and young people various craft activities relating to the topic of light, was still going after 12. A huge thank you to everyone who contributed to this wonderful evening.

People of all ages gathered for the show «Funken, Blitz und Donner» and were waiting in front of the laser labyrinth during the whole evening.

Nanotechnology in Northwestern Switzerland

On September 9, the annual i-net Nano Technology Event took place at the University of Applied Sciences Northwestern Switzerland in Muttenz in collaboration with the SNI. A number of talks and posters focused on Argovia projects successfully conducted in previous years by SNI members working with companies from the region.

i-net Nano frequently organizes interesting events on various aspects of nanotechnology. For more information, visit: www.i-net.ch/nano/events/

Lively discussions between posters during the i-net Nano Technology Event (Image: i-net Nano)

Exciting Events of the NCCR MSE

22 October 2015:
«Tatort» Mitte, Basel, 7.20 pm
Basar Molekular
with Anita Fetz (Council of States member Basel-Stadt), Felix Gmür (bishop of Basel), Stefan Gubser (actor, "Kommissar Reto Flückiger" in "Tatort") and Daniel Müller (Professor for Biophysics and Co-Director of the NCCR MSE).

28 October 2015: SeminBar, 6 pm
with Professor Andreas Plückthun (University of Zürich) in the Ackermannshof.

More information: www.nccr-mse.ch

Expo Nano in Basel

From September 28 until October 24, the exhibition «Nanomaterialien heute – Chancen oder Gefahren?» takes place in the library Schmiedenhof.

More information at:
http://exponano.ch

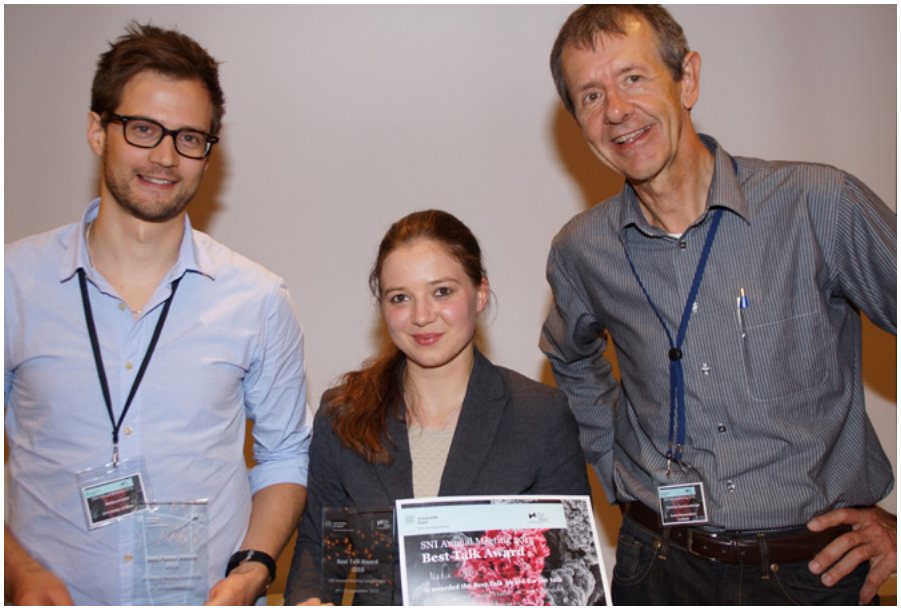
Scientific Diversity in Lenzerheide

From September 3–4, 2015, the SNI's second annual event took place in the Hotel Schweizerhof in Lenzerheide. Once again, more than 70 SNI doctoral students and other SNI members gained an insight into the fascinating and varied world of SNI nano research.

The invited speakers – Professor Martino Poggio, Professor Uwe Pieles, Professor Daniel Loss, Professor Henning Stahlberg, and Professor Clemens Dransfeld – provided an overview of their research areas. Numerous doctoral students from the SNI PhD School presented their work and some Argovia project leaders reported on the latest results from their projects. This year, a lively poster session and an excellent evening meal were followed by a very special dessert. Professor Daniel Loss gave a talk on the quantum world, in which he develops theories to help us understand this world.

At the end of the meeting, SNI director Christian Schönenberger had the pleasure of presenting a few awards. Sara Freund received the award for the best nanoscience Master's thesis in 2014. Nadia Opara was awarded the prize for the best talk and Stefan Arnold was recognized for his poster. Heartfelt thanks were also expressed to the organizational team including Kerstin Beyer-Hans, Sandra Hüni, and Claudia Wirth, who ensured that everything went perfectly.

Next year's conference will be held on September 15–16, 2016.



Stefan Arnold and Nadia Opara received their awards for the best poster and the best talk from Christian Schönenberger.

Top Marks for INASCON 2015 in Basel

From August 11–14, 2015, Basel hosted the 9th INASCON (International Nanoscience Student Conference). 90 students from 14 countries took part in this interdisciplinary conference for and by nanoscience students. The organizational team, which included two nano students and six nano doctoral students from Basel, had prepared an excellent conference. They put together a varied program, secured numerous sponsors, and ensured that every last detail was organized and executed perfectly.

The participants were very impressed by the academic presentations given by renowned scientists such as Charles Marcus and Michael Grätzel and entrepreneur Felix Holzner, who inspired the young

The organizational team of INASCON 2015 received top marks.

attendees and clearly explained complex topics. The presentations and posters by the participating students were also positively received, with attendees rating the conference as “very good”. A total of 80 percent of all visitors expressed their wish to return next year, certainly due in part to the entertaining evening program, which helped them discover Basel and Switzerland a little more closely.

Media releases and uni news from SNI members

University of Basel, 9th October 2015. Controllable protein gates deliver on-demand permeability in artificial nanovesicles

Researchers at the University of Basel have succeeded in building protein gates for artificial nano-vesicles that become permeable only under specific conditions. The gate responds to certain pH values, triggering a reaction and releasing active agents at the desired location. This is demonstrated in a study published in the journal “Nano Letters”.

i-net, 7th October 2015. Christian Bosshardt will become Head of the Technology Field Nano at i-net

With Christian Bosshardt, i-net innovation networks Switzerland (the joint innovation support of the cantons in Northwestern Switzerland) could win an excellent expert as Strategic Head of the Technology Field Nano. Christian Bosshardt is Director of the CSEM in Muttenz. He will strategically support i-net and provide his knowledge and contacts.

University of Basel, 8th September 2015. Researchers in Basel Develop Ideal Single-Photon Source

With the help of a semiconductor quantum dot, physicists at the University of Basel have developed a new type of light source that emits single photons. For the first time, the researchers have managed to create a stream of identical photons from a semiconductor. They have reported their findings in the scientific journal “Nature Communications” together with colleagues from the University of Bochum.

University of Basel, 8th September 2015. Improved stability of electron spins in qubits

Calculation with electron spins in a quantum computer assumes that the spin states last for a sufficient period of time. Physicists at the University of Basel and the Swiss Nanoscience Institute have now demonstrated that electron exchange in quantum dots fundamentally limits the stability of this information. Control of this exchange process paves the way for further progress in the coherence of the fragile quantum states. The report from the Basel-based researchers appears in the scientific journal “Physical Review Letters”.

University of Basel, 7th September 2015. Molecular bodyguards for immature membrane proteins

During their formation within the cells, many proteins rely on the assistance of molecular protectors, so-called chaperones. They help the proteins to fold correctly and thus ensure the right final structure. The roles of chaperones in membrane protein folding have long remained unclear. Researchers at the Biozentrum, University of Basel, and at ETH Zurich have now shown how chaperones stabilize an immature bacterial membrane protein and guide it in the right folding direction, thus protecting it from misfolding. Their study was recently published in “Nature Structural & Molecular Biology”.

University of Basel, 2nd September 2015. Physics award for Peter Rickhaus

The young scientist Peter Rickhaus from the Department of Physics and the Swiss Nanoscience Institute at the University of Basel has been awarded the Metas-Price of the Swiss Physical Society for his work on electron transport in graphene.

University of Basel, 27th August 2015. Successful boron-doping of graphene nanoribbon

Physicists at the University of Basel succeed in synthesizing boron-doped graphene nanoribbons and characterizing their structural, electronic and chemical properties.

The modified material could potentially be used as a sensor for the ecologically damaging nitrogen oxides, scientists report in the latest issue of "Nature Communications".

University of Basel, 16th July 2015. Quantum States in a nano-object manipulated using a mechanical system

Scientists at the Swiss Nanoscience Institute at the University of Basel have used resonators made from single-crystalline diamonds to develop a novel device in which a quantum system is integrated into a mechanical oscillating system. For the first time, the researchers were able to show that this mechanical system can be used to coherently manipulate an electron spin embedded in the resonator – without external antennas or complex microelectronic structures. The results of this experimental study will be published in "Nature Physics".

Please provide feedback

Please share with us (c.moeller@unibas.ch) your news, success stories, and feedback so that we can include it in SNI update.