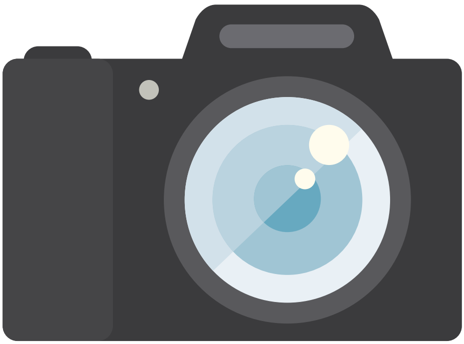
D-ITET

RESEARCH PHOTO COMPETITION 2019

DOCUMENTATION OF SUBMISSIONS



D ITET

ETH zürich

At D-ITET, a lot of brilliant research is conducted. We are proud of our researchers and we want them and their work to get the recognition they deserve. We would like to provide the public with an inside view into our labs and share the creativity, determination and passion of the people behind many groundbreaking projects. That's why the department has decided to launch the D-ITET Research Photo Competition 2019. Enjoy the collection of 43 great photos and stories that have been submitted by our researchers!

Prof. Christian Franck
Delegate for Communication and PR

D-ITET RESEARCH PHOTO COMPETITION 2019

These are the winners of the D-ITET Research Photo Competition 2019:

1st prize: Raphael Färber (HVL), **Nr. 32**

2nd prize: Tamara Popovic (MWE), **Nr. 18**

3rd prize: Andreas Messner (IEF), **Nr. 25**

4th prize: Johannes Rebling (IBT), **Nr. 7**
Olesya Yarema (IfE), **Nr. 26**
Johannes Burkard (HPE), **Nr. 34**
Pascal Bleuler, Tim Schultz (HVL), **Nr. 41**

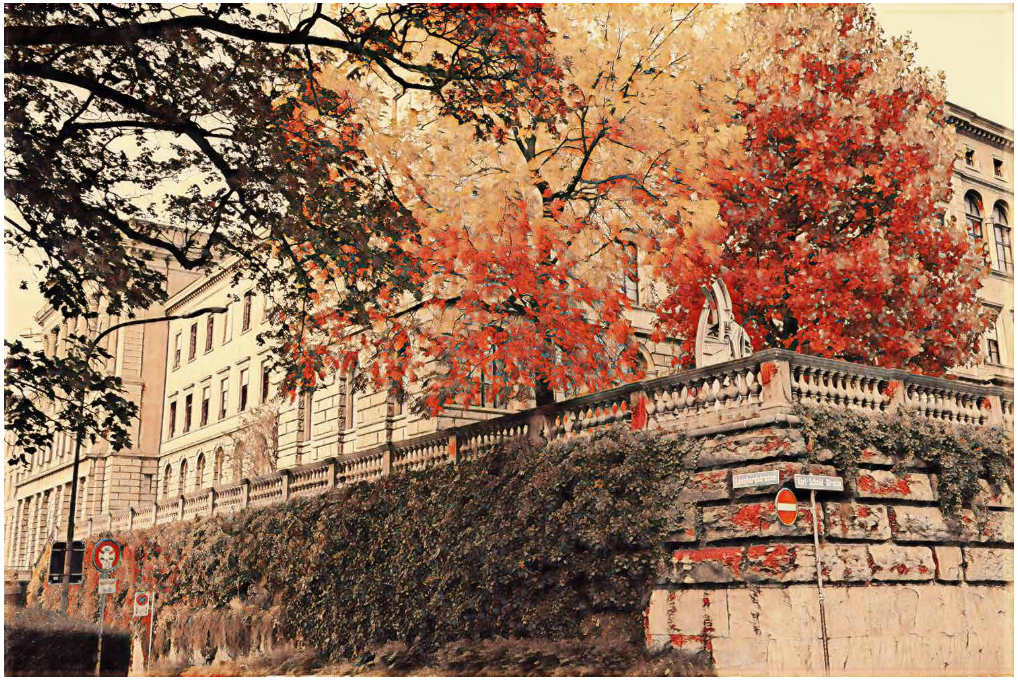
D-ITET RESEARCH PHOTO COMPETITION 2019

ETH comes into the picture as the artist works

With the photos taken in ETH campus as input, the image is generated from our DLOW model, which can translate the photography into different paintings with different artist's styles in a unified model, e.g. the Monet, Van Gogh, Ukiyo-e and Cezanne style in our example.

Application: When we take photos, many of us have ever imagined how the great artists depict the scenery with their brushes. Unfortunately, the great artist may not see the same scene and we cannot find the corresponding artworks. However, thanks to the development of the deep learning, our deep learning model DLOW can bring the imagination into reality and generate the paintings of the scenery just as the artists work. Moreover, our model is like a generalist and can imitate the styles of different artists.

Name: Rui Gong
Position: Master's Student
Lab: Computer Vision Laboratory (CVL)
Other team members: Wen Li, Postdoc, (CVL) / Carlos Eduardo Porto de Oliveira, Project Staff, (CVL)



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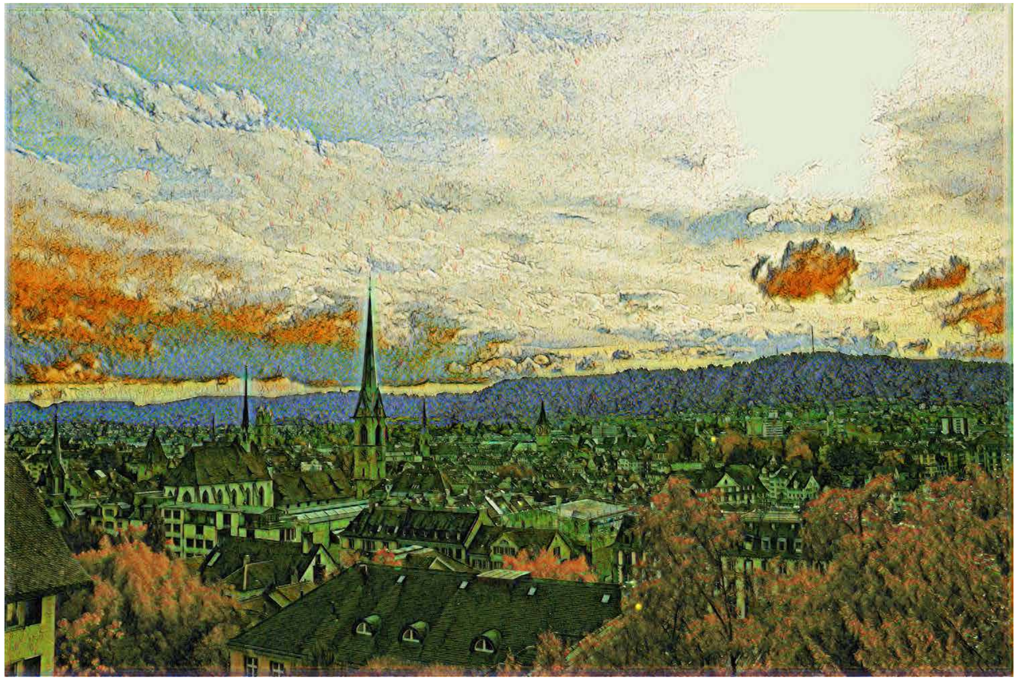

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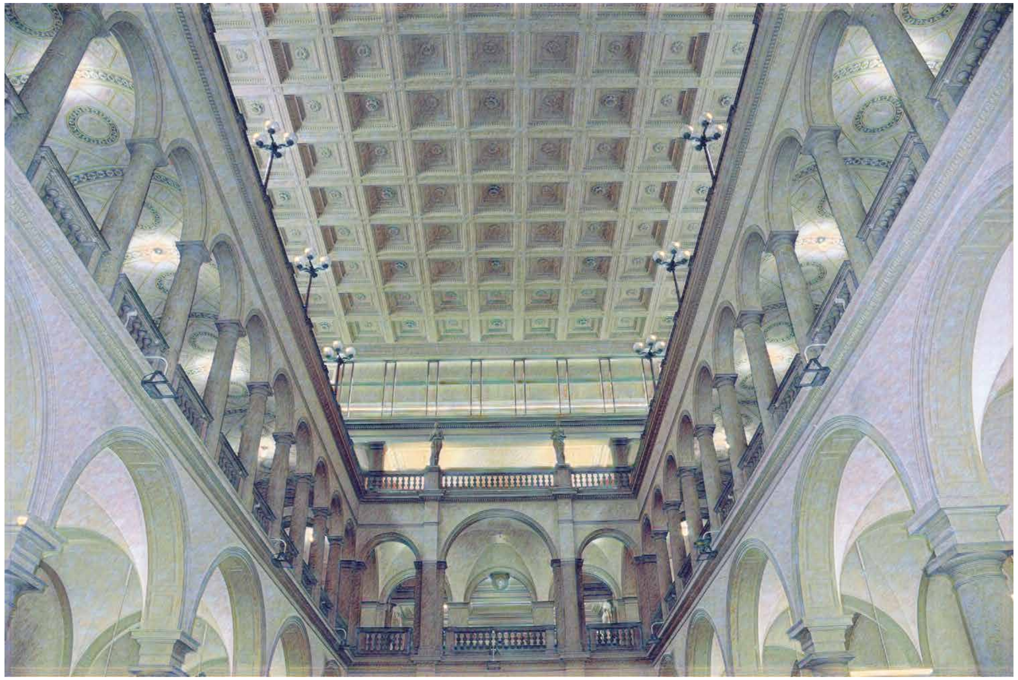

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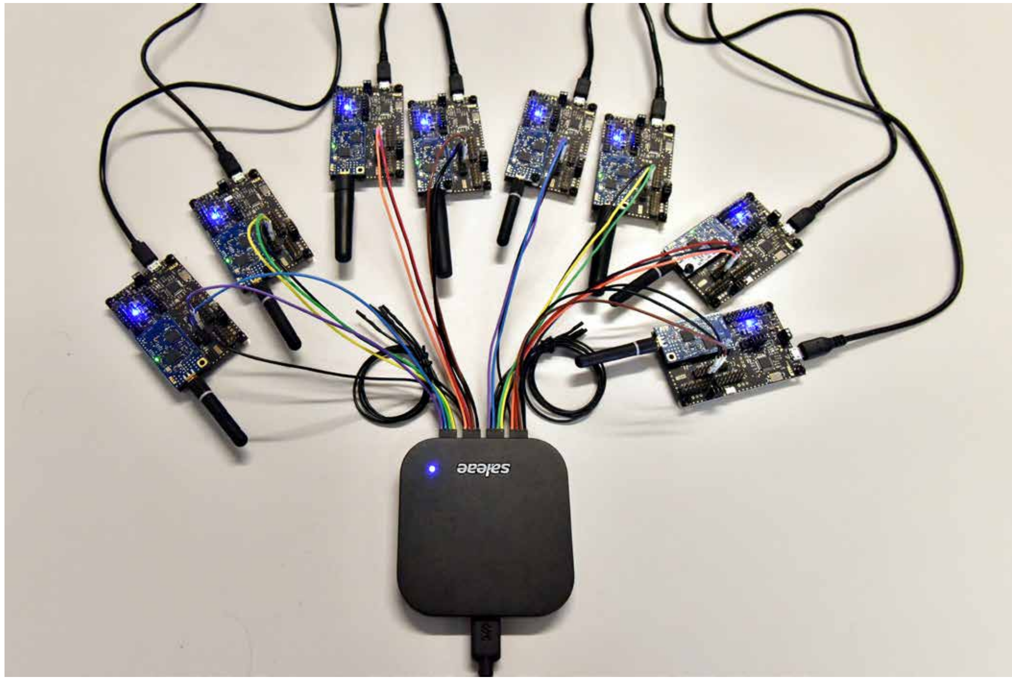

Connected objects – the monsters of the digital age?

Smart objects are part of our lives. Everything gets connected and continuously exchanges information. More information about our tastes and habits let the objects around us provide better, tailored services. We dream of simpler and happier lives.

But this may also be a daunting prospect. Aren't fictions like 1984, or The Matrix turning into reality?

The speed of changes can be petrifying! The risk is to see things go out of control. This is why scientists need to understand better how to use new technology, such that it helps to make our like easier; not turning the dream into nightmare.

This picture shows an experiment to measure the precision of time synchronization between different radios. In wireless communication, precise timing is key to minimize energy consumption, which is a major challenge for the future of connected objects. A logic analyzer (the petrifying Medusa's head) is used to monitor the operations of 8 radios, which are synchronizing themselves wirelessly.

Name: Romain Jacob
Position: Doctoral Student
Lab: Computer Engineering and Networks Laboratory (TEC)

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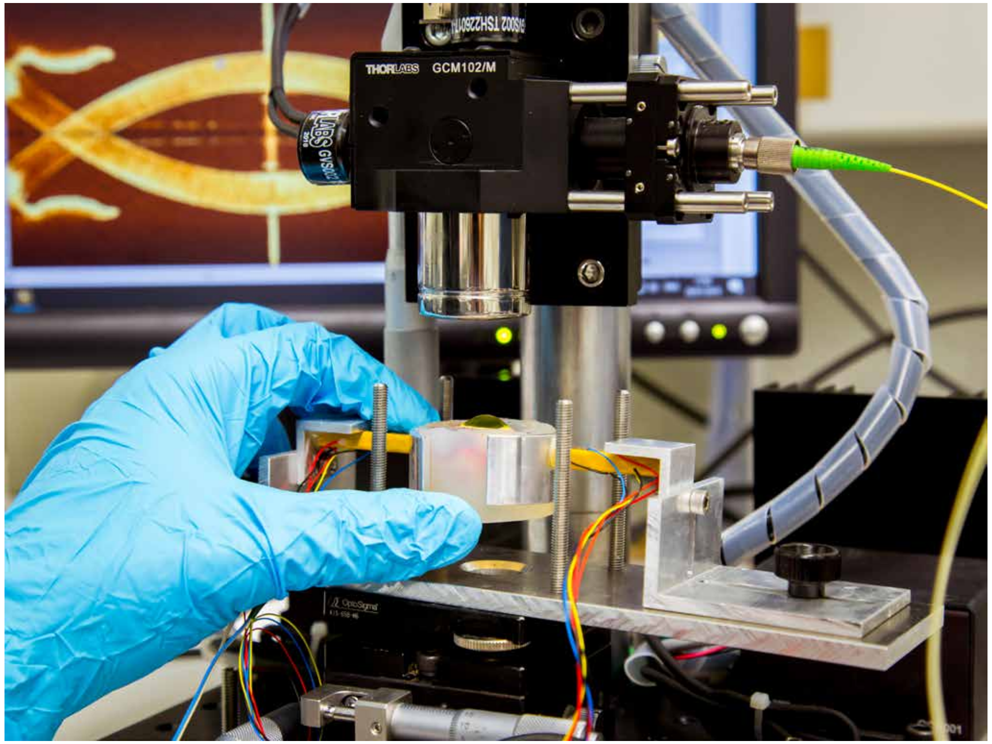
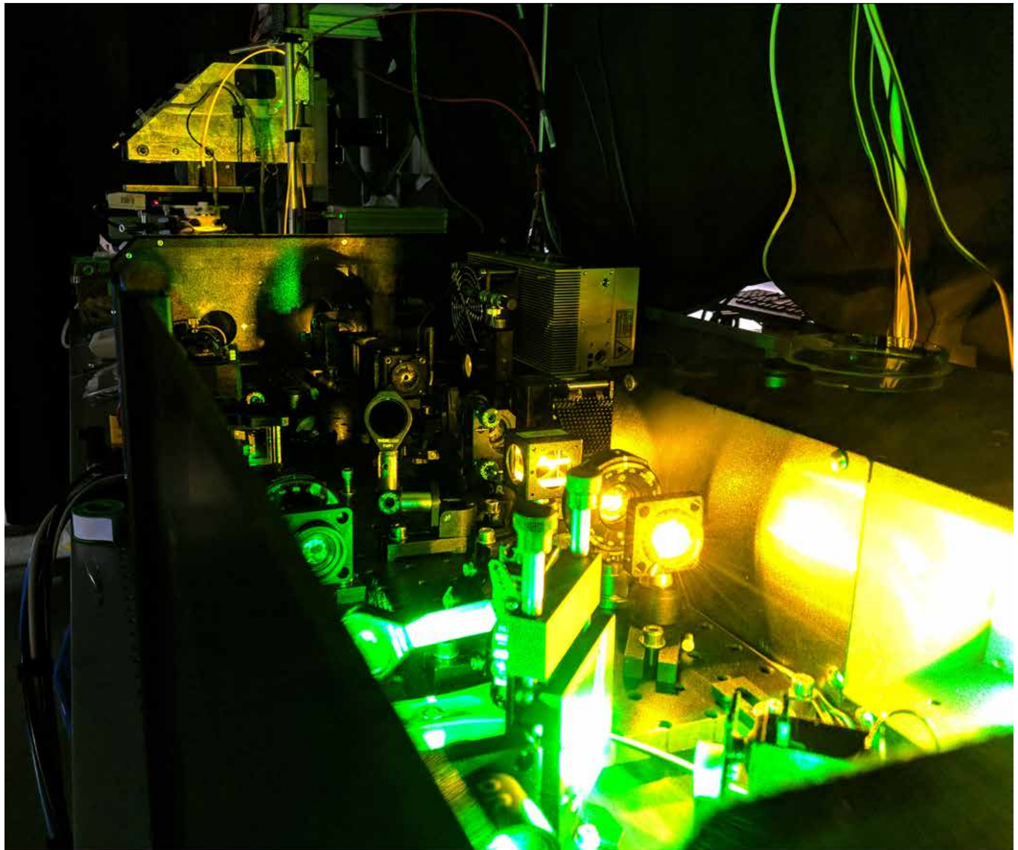


Nature made optical system imaged by human made optical system

The eye – an optical imaging system originating from nature – is being imaged with an optical coherence tomography system made by humans. The optical quality of the human-made system is much higher than the optical quality of the eye and allows resolving sub-micrometer deformations. While the porcine eye is aligned with the scanning apparatus, the real-time tomographic image of the cornea is shown on the computer screen in the back. The particular interest of the current set-up is to measure the propagation of waves throughout the eye in an effort to determine its mechanical properties. The laterally mounted yellow piezoelectric actuators are used for controlled wave generation. The investigated technique could become helpful in the early diagnosis of pathologic degradations in ocular tissues and contribute to prevent visual quality loss in humans.

Name: Sabine Kling
Position: Lecturer / Wissenschaftliche Oberassistentin
Lab: Computer Vision Laboratory (CVL), Computer assisted Applications in Medicine group



07
Biomedical Engineering
and Neuroinformatics

4th Prize

D-ITET RESEARCH PHOTO COMPETITION 2019

Listening to light in the brain

The brain requires an efficient blood supply like any other tissue. Understanding when and how the blood vessels fail to bring enough oxygen and nutrients to the brain is essential for understanding many diseases. Optical microscopy can show researchers features of these blood vessels, but it requires long imaging time, it can look at only very small areas of the brain at a time, and it cannot look at areas deep inside the brain. To improve on these disadvantages, we are developing a microscope that combines ultrasound with an emerging technique called optoacoustic microscopy. For this, ultra-short and ultra-bright laser pulses are generated (top image) and sent into the mouse brain (bottom image), where they generate ultrasound waves which we can measure in order to create an image. With this new approach we can image the mouse skull, the brain inside, and the entire network of blood vessels in the cortex. This system may be a powerful research tool for understanding many neurological defects.

Name: Johannes Rebling
Position: Researcher
Lab: Institute for Biomedical Engineering (IBT), Prof. Razansky
Other team member: Urs Hofmann, Doctoral Student

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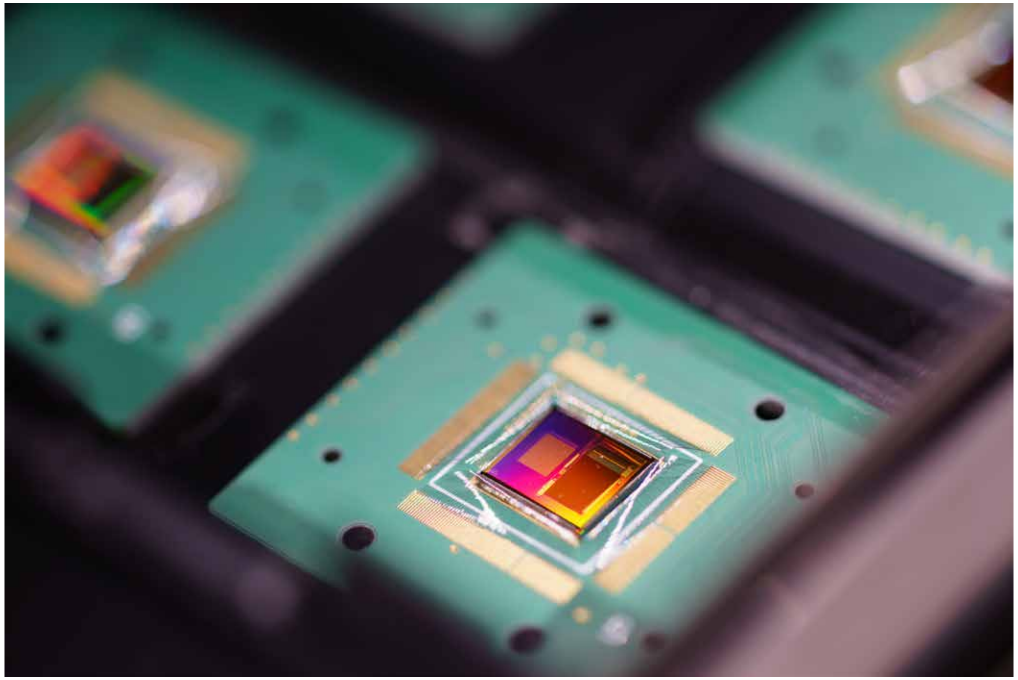
2019



The neuromorphic *Bioamp* chip, to enhance real-time brain-machine interfaces.

Neuromorphic technologies allow new paradigms in data acquisition and processing. Instead of sampling signals in a Shannon fashion at fixed data-rates, the information is here transmitted only if a significant change is detected, in an asynchronous manner, then natively removing data redundancy. Why spending energy and time to acquire, transfer, process and store data that is useless for the final application ? These disruptive processes allow a higher temporal resolution at a lower power budget. With this, we aim to build a fully embeddable pipeline for neural data acquisition and processing, enhancing brain machine interfaces for rehabilitation processes. Here, we show our first prototype of 32x32 electrodes with a 100um pitch, fabricated in 180nm CMOS process, consuming less than 90uW.

Picture taken with Sony a7II, 100mm lens, f/2.8, 1/125sec.

Name: Germain Haessig
Position: Postdoc
Lab: Institute of Neuroinformatics
Other team members: Matteo Cartglia, Doctoral Student, Institute of Neuroinformatics /
Giacomo Indiveri, Director, Institute of Neuroinformatics

D-ITET RESEARCH PHOTO COMPETITION 2019

An advancing method to detect and quantify cardiac infarction

Heart disease is the leading cause of death worldwide. Since metabolic changes are not only a consequence but also a cause of such diseases, there is a need for an imaging technique to study cardiac metabolism, i.e. the heart's sugar consumption.

Magnetic Resonance Imaging (MRI) combined with an injectable tracer is one way to monitor cardiac metabolism. However, to make the tracer visible for MRI, its signal strength has to be increased by a step known as hyperpolarization.

To prepare the tracer for hyperpolarization, it has to be frozen in liquid nitrogen which is shown in the photo. The picture depicts a black plastic vial which contains the tracer and is connected to a transparent tube. When placing the vial in liquid nitrogen, the tracer not only freezes but due to the temperature gap, the nitrogen starts to boil which can be seen by the bubbles.

Hyperpolarized MRI is an advanced imaging technique to assess cardiac metabolism. Currently our group is translating this technique into the clinic. In the future, hyperpolarized MRI could be used to detect and quantify cardiac infarction in the clinical routine.

Name: Julia Traechtler
Position: Doctoral Student
Lab: Cardiovascular Magnetic Resonance, Prof. Kozerke, Institute for Biomedical Engineering

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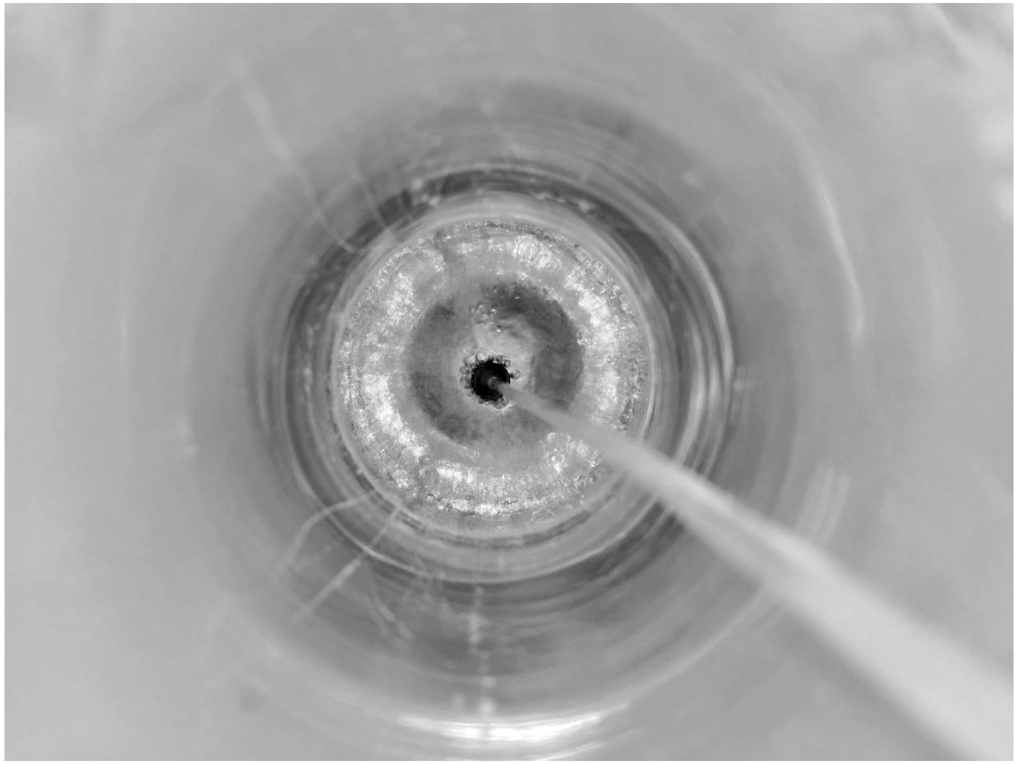

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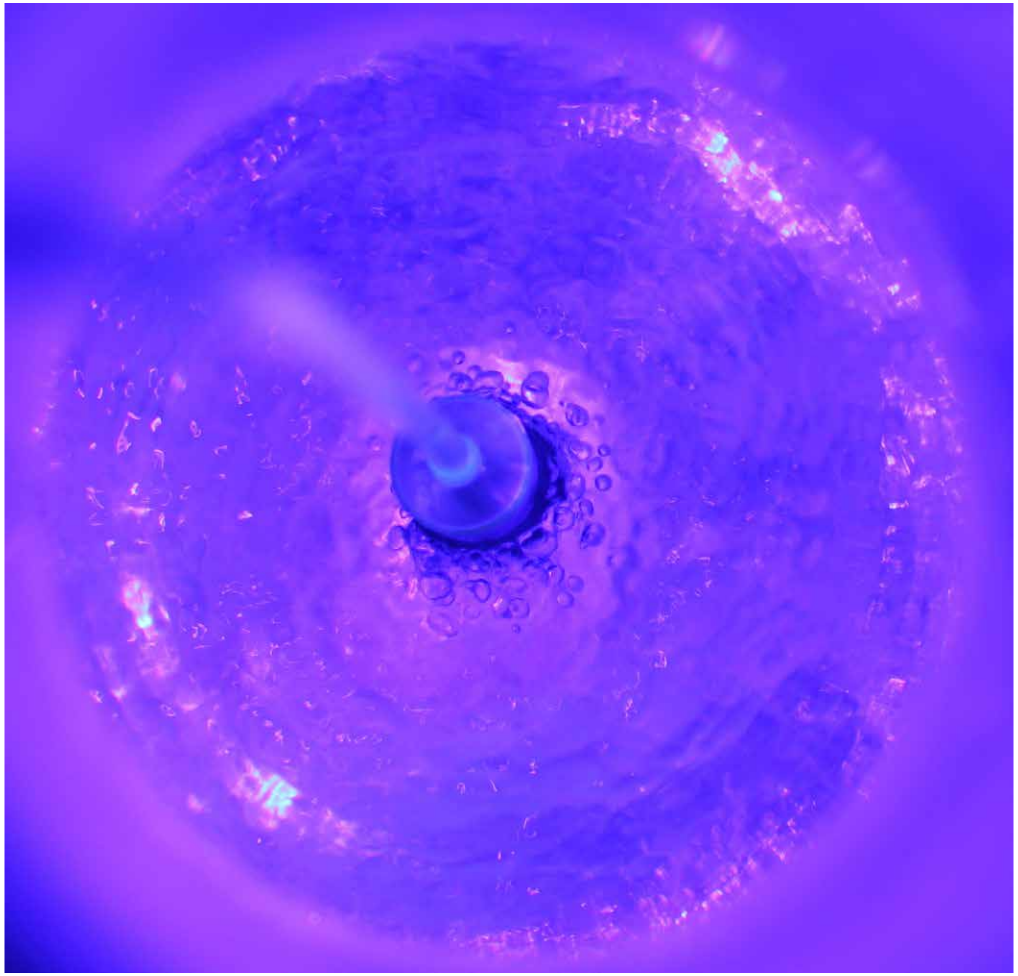

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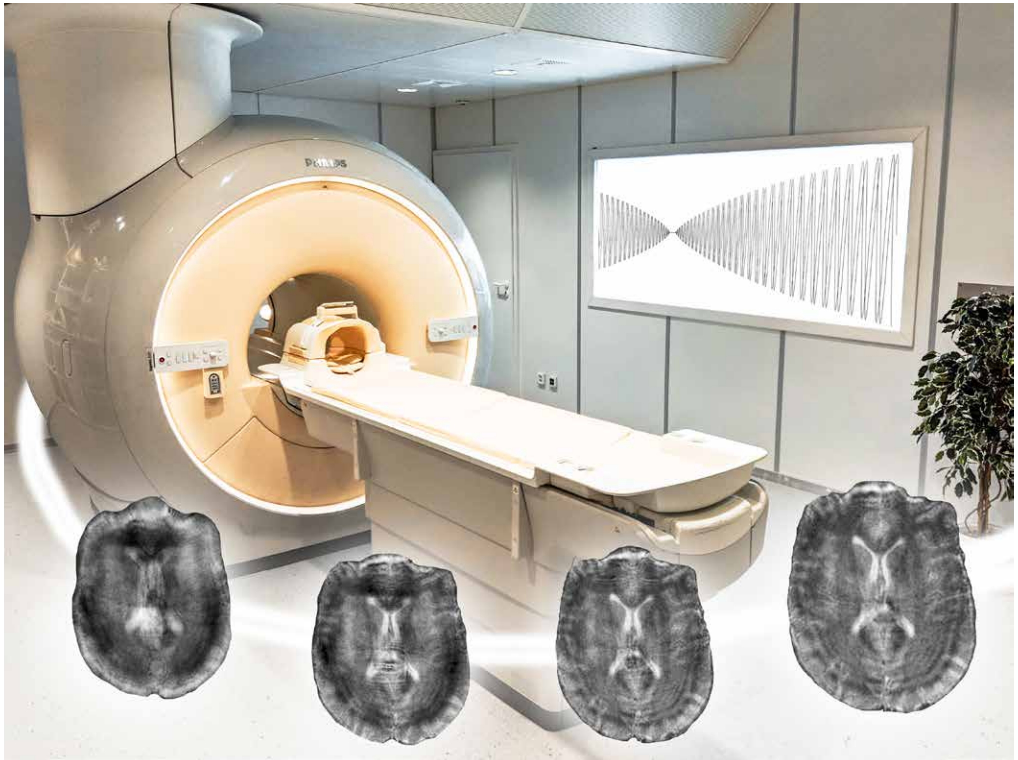

Self-correcting MRI images: Better look at your object twice to really know it

Magnetic resonance imaging relies on strong magnetic fields to image different substances. Due to differences in the magnetic susceptibilities of the diverse chemical structures in the brain, i.e. water, fat, muscle, grey and white matter or air, the effect of the applied magnetic field is changed locally which distracts the imaging process when quick imaging techniques are used. You can think of this as quickly painting on a rough surface which won't work as good as if you were painting on a flat surface. A preparation scan which usually takes some minutes can be used to characterize the effective field or spoken in the illustration above: your surface.

An approach we are working on to correct for these distortions is to acquire some data twice at different points in time using an in-out trajectory which is displayed at the screen. It takes only around 50 ms to run it! One can think of this as circularly walking to and away from the center of a court and hence feeling the roughness of the underground in two different directions which can be used to first characterize them and then correct your image using this knowledge. The iterative process of the correction (optimization) is shown by the brain images at the bottom.

Name: Franz Patzig
Position: Doctoral Student
Lab: Institute for Biomedical Engineering (IBT)

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Ice blue

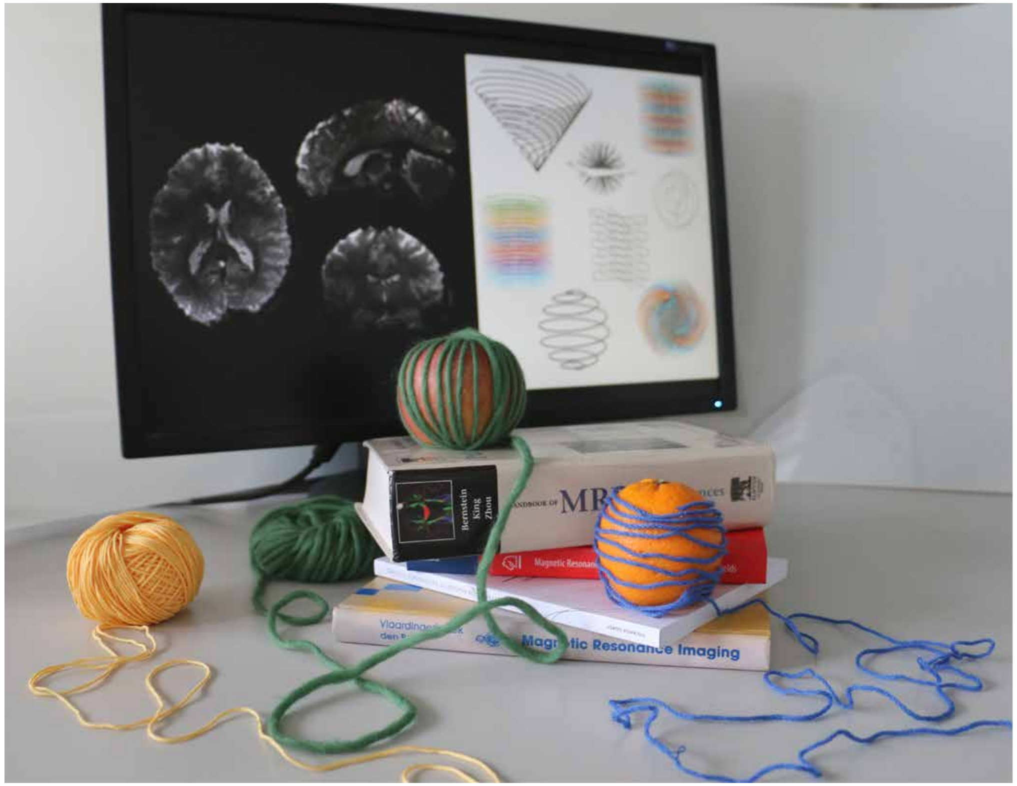
We study neurotransmitter systems which control nonvolitional phenomena (e.g. emotion, motivation), and how popular drugs affect them. In order to pick up increasingly fine effects of drugs on these systems we look to implement high-fidelity cryogenic coils. This is easier said than done, since such coils contain supercooled fluid and cannot be modified to permit the implants, which we use to stimulate our target neuronal systems, to pass through. As such we have had to adapt the implant and operation procedure to fit the enhanced acquisition. Here one of our set-ups is fully deployed to perform high-fidelity magnetic resonance imaging while stimulating neurons via an ice blue laser beam.

Name: Horea-Ioan Ioanas
Position: Doctoral Student
Lab: Animal Imaging Center

Interdisciplinary multitasking

We explore neurotransmitter systems which control nonvolitional phenomena (e.g. emotion, motivation), and how popular drugs affect them. Our research lies at the confluence of molecular biology, pharmacology, magnetic resonance physics, and computer science. Each of our measurement sessions includes anesthesia, physiological monitoring, drug and contrast agent delivery, laser stimulation, scanner operation, and supervised recovery. Additionally, the process optimization in our facility permits the operation of multiple scanners in parallel, by experimenters proficient in all relevant steps. Interdisciplinary multitasking is how it's done, and being a 9-man team is the way to do it.

Name: Horea-Ioan Ioanas
Position: Doctoral Student
Lab: Animal Imaging Center



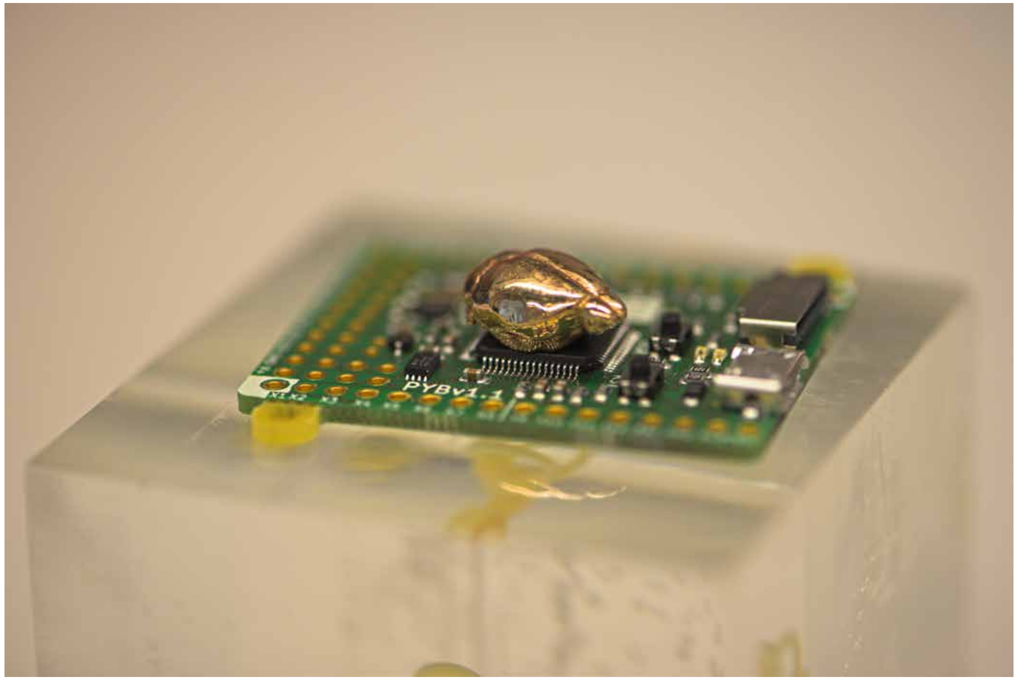
What is the fastest way to acquire an MR image?

Functional magnetic resonance imaging is a technique where time series of the brain are recorded. Scientists studying human behavior give for example visual stimuli to volunteers, and observe the reaction in the MRI scanner. Thereby, they can find out important aspects about how our brain functions.

In order to do so, they need to record many images very quickly one after the other. In our research, we try to find the fastest way to acquire these images. That corresponds to the question about the fastest way of sampling a 3-dimensional volume (Fourier-space). This task can be compared to winding up threads of cotton such that they have a similar distance everywhere. The rules: Time is lost by making sharp curves and neighbors should be sampled at similar times.The answer depends strongly on the amount of threads we want to spend and on the image resolution we desire, but also on the geometric arrangement of the MR experiment.

Should we rotate on spherical shells from north to south pole? Or wind threads up like a yarnball? Or better run on concentric cones? What about spirals piled up to a cylindrical stack?

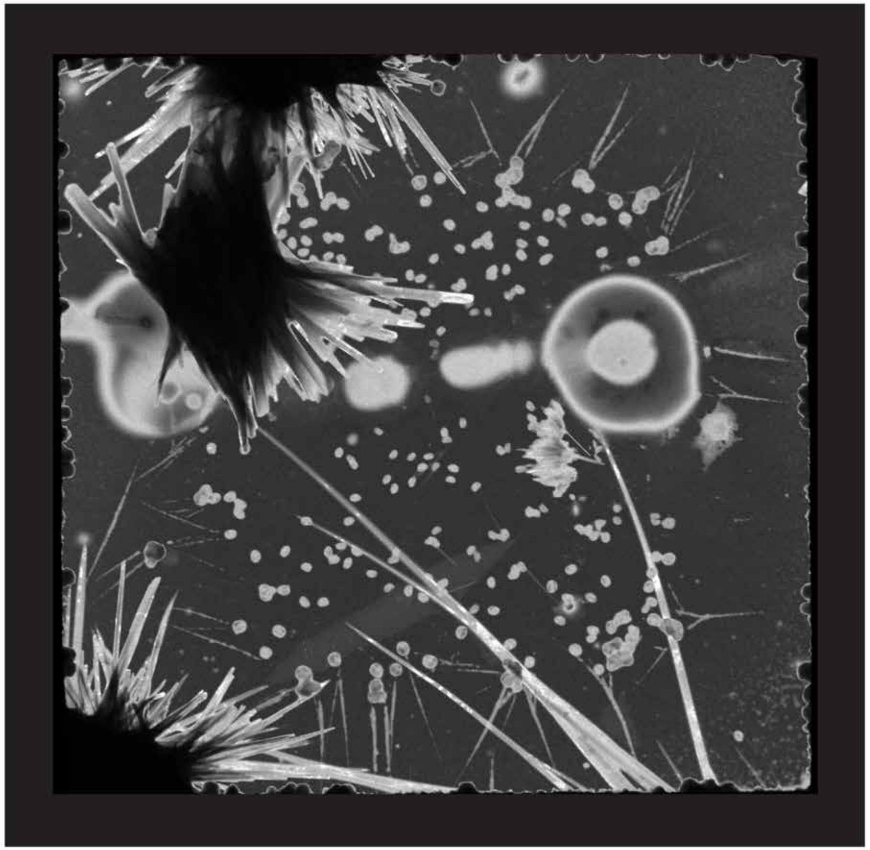
Name: Maria Engel
Position: Doctoral Student
Lab: Magnetic Resonance Technology and Methods Group (MRTM, Prof. Pruessmann),
Institute for Biomedical Engineering (IBT)



Mouse brain circuit

We work on spatial matching between functional, cellular, and molecular features in the brain. This consists of introducing activity into the brain via accurately timed stimulus trains (driven with the attached circuit, a pyboard), and obtaining spatial maps of neuronal activity in the brain. In order to better understand these networks, we correlate them against a database of functional and molecular maps, and develop cutting-edge visualizations. Our latest development is printing our "figures" in real-life 3D instead of 2D on paper or a monitor. This allows much more better spatial understanding and inspection, and the variety of available materials (from metal all the way to acrylic glass) allow us to optimize our tangible visualizations for durability, beauty, simplicity, or depth of features. The intersection of high-level research (high-throughput programming, big data analysis, electrical engineering, biology) and sheer beauty should make our work more accessible and pleasurable to behold not only for us, but for anybody.

Name: Tina Segessemann
Position: Master's Student
Lab: Institute for Biomedical Engineering, Functional and Molecular Imaging Lab
Other team member: Horea-Ioan Ioanas, Doctoral Student, Functional and Molecular Imaging Lab



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Window to another world

This image was taken on a Scanning Transmission Electron Microscope at ScopeM (Scientific Center for Optical and Electron Microscopy). We use this technique to characterize the size, composition and crystal structure of our nanocrystals. The support grids are made of a copper mesh covered with a very thin carbon layer. A focused electron beam then scans across the image and detectors capture scattered light for each pixel. In this image, you can see one window of the copper mesh, approximately 100µm in length.

What exactly went wrong with this grid, I do not know. The carbon layer is torn in three places. A lot of organics create a strange pattern that look like a window to another world. Everyone I ask sees something different in this window, so I will not take the fun away from you to imagine yourself what you see.

Name: Annina Moser
Position: Doctoral Student
Lab: Materials and Device Engineering Group (MaDE), Institute for Electronics

2nd Prize

D-ITET RESEARCH PHOTO COMPETITION 2019

From our hands to the space: receiving data with maximum quality

The planetary distances between the ground antennas and spacecrafts contribute to enormous requirements on the sensitivity of Earth-based receiver systems. By using our low noise transistors, the receptors are able to amplify the incoming space signals with the best possible quality due to their excellent properties. Our manufactured microchips have been present in some of the latest missions of the ESA (Europe Space Agency) and are expected to contribute to modern communication networks such as 5G and beyond.

In the image are Tamara and Diego looking at their fabricated HEMT (High Electron Mobility Transistor) with SEM (Scanning Electron Microscopy) tool in FIRST Laboratory together with an image of ESA's ground antenna added in the background. Devices we design have gate lengths bellow 100 nm and are reaching very high operating frequencies keeping an extremely low noise level. They are considered the best option for low noise amplifiers at both room and cryogenic temperatures, playing a key role in deep-space communications and radio-astronomy systems.

Once the growth of different layers is finished, a sequence of several fabrication steps are needed to achieve a working HEMT (High Electron Mobility Transistor) or HBT (Heterojunction Bipolar Transistor) device, some of the fastest transistors today used in communication systems.

Name: Tamara Popovic
Position: Doctoral Student
Lab: Millimeter-Wave Electronics Laboratory (MWE Lab)
Other team members: Diego Calvo Ruiz, Doctoral Student, (MWE Lab) /
Daxin Han, Doctoral Student, (MWE Lab) / Olivier J. S. Ostinelli, Permanent Researcher, (MWE Lab)

Atomic control at the nanoscale

The MWE Group research activities focus on high-speed semiconductor devices built in the AlGaInN/GaN, InP/GaAsSb and AlInAs/ GaInAs/InP material systems and their alloys. We exploit "Bandgap Engineering" techniques to develop new millimeter-wave transistors such as Heterostructure Bipolar Transistors (HBTs) and High Electron Mobility Transistors (HEMTs). Our projects are impactful: over the years, multiple bandwidth records for InP bipolar transistors were set, and a number of devices have found industrial application and commercialization.

In the picture is Diego holding a diamond crystal lattice wearing the cleanroom suit from FIRST Laboratory. The MWE Group also teaches the 'Semiconductor Devices' course every Spring Semester where they introduce the basics of semiconductor physics to DITET bachelor students. The crystal structure of solids and the properties semiconductors are fundamental part of the course. The diamond lattice is a tool used in the exercises to help students understand and visualize the materials in 3 dimensions.

Name: Tamara Popovic
Position: Doctoral Student
Lab: Millimeter-Wave Electronics Laboratory (MWE Lab)
Other team members: Diego Calvo Ruiz, Doctoral Student, (MWE Lab) /
Daxin Han, Doctoral Student, (MWE Lab) / Olivier J. S. Ostinelli, Permanent Researcher, (MWE Lab)

Hands in the new materials for the future

Tamara has her hands in the reactor chamber of the MOCVD (Metal-Organic Chemical Vapor Deposition) machine in FIRST Laboratory with a molecular structure image added in the background. MOCVD tool uses ultrapure gas molecules to deposit a very thin layer of atoms onto a semiconductor wafer, enabling the fabrication of new structures with nanometric precision. Using this technique many different materials can be constructed, each of a precisely controlled thickness and composition, to create a layer which has specific optical and electrical properties.

Once the growth of different layers is finished, a sequence of several fabrication steps are needed to achieve a working HEMT (High Electron Mobility Transistor) or HBT (Heterojunction Bipolar Transistor) device, some of the fastest transistors today used in communication systems.

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Position: Doctoral Student
Lab: Millimeter-Wave Electronics Laboratory (MWE Lab)
Other team members: Tamara Popovic, Doctoral Student, (MWE Lab) / Daxin Han, Doctoral Student, (MWE Lab) / Olivier J. S. Ostinelli, Permanent Researcher, (MWE Lab)

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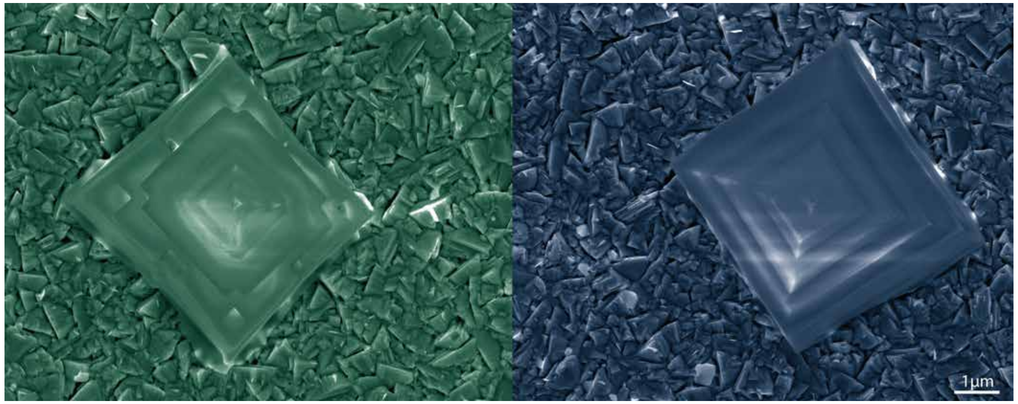
Prime quality manual labor in the cleanroom

In the picture are Tamara and Diego fixing the cryo pump of the Electron-Beam Evaporator in FIRST Laboratory. FIRST cleanroom has about 400 square meters of ultra clean processing environment for micro- and nanoscience experiments. Young scientists have the opportunity to work in the field of photo- and nanolithography, to carry out thin film deposition processes, to analyze and characterize their processed samples and to learn about epitaxy of semiconductors.

Most users of the lab, who vary from senior scientists to semester students, have to be responsible of certain equipment, taking care of the maintenance and possible issues. This makes running a laboratory with more than 300 active users and almost 50 research groups involved possible. The outcome is very fruitful, more than 100 publications per year are based on devices or structures manufactured in this lab.

Name: Diego Calvo Ruiz
Position: Doctoral Student
Lab: Millimeter-Wave Electronics Laboratory (MWE Lab)
Other team members: Tamara Popovic, Doctoral Student, (MWE Lab) / Daxin Han, Doctoral Student, (MWE Lab) / Olivier J. S. Ostinelli, Permanent Researcher, (MWE Lab)



Salt on CIGS

Colorized scanning electron micrograph of table salt (NaCl) deposited on a Cu(In,Ga)Se2 (CIGS) surface. The scale is shown in the image. CIGS is used as absorbing material in thin film chalcopyrite solar cells. The image was recorded in the cause of an experiment where salt was introduced in a test structure to pattern a subsequently deposited layer. For this purpose the substrate was dipped in a hot saturated solution of NaCl for a short period of time resulting in a crystallization of the salt on the surface of CIGS. In further processing of the solar cell the salt would be removed by rinsing with water leaving a pattern in the on-top deposited film.

Name: Johannes Löckinger
Position: Doctoral Student
Lab: 207, Empa

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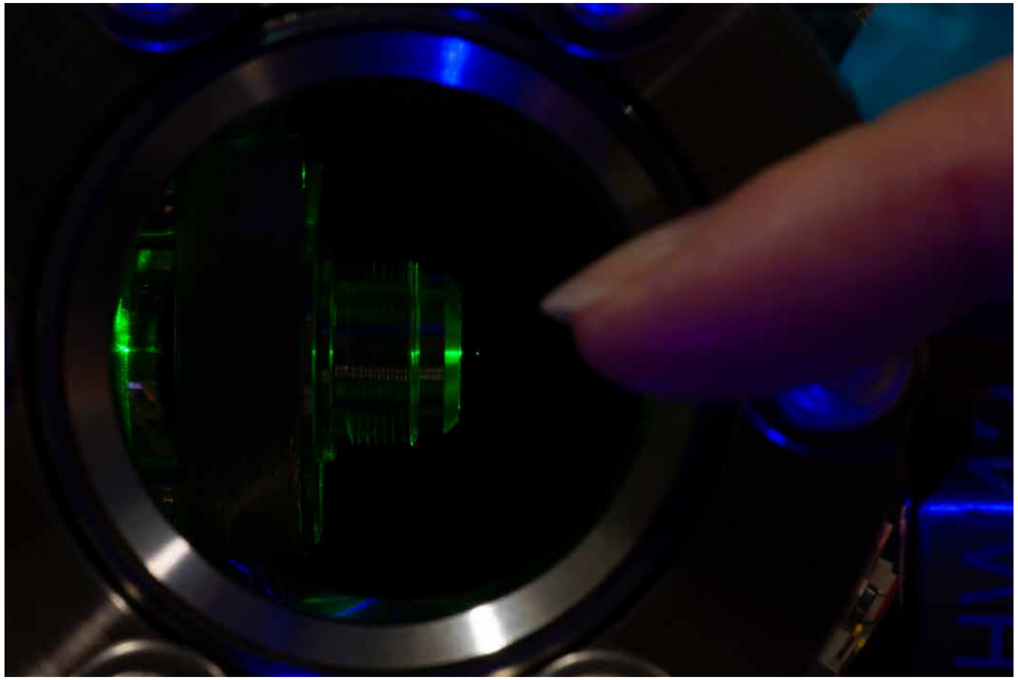

Little sun – A levitated nanoparticel for inertial sensing

Rozenn, a PhD student in the Photonics Laboratory, points at a levitated nano-particle inside a vacuum chamber. The tiny glass particle has a diameter that is a thousand times smaller than the diameter of a human hair and is trapped and illuminated by laser beams. The beams are focused onto the particle by a lens which is left to the particle and held in a metallic lens holder.

Levitated particle systems are very well isolated from noise and can be mani-pulated and measured with highest precision. These key features render those systems ideal for quantum-enhanced high-end inertial sensing, that could be used for satellite missions, seismic measurements or also in autonomous cars.

Name: Rene Reimann
Position: Postdoc
Lab: Photonics Laboratory
Other team members: Rozenn Diehl, Doctoral Student (just finished) / Martin Frimmer, Postdoc / Andrei Militaru, Doctoral Student / Lukas Novotny, boss / Felix Tebbenjohanns, Doctoral Student / Fons van der Laan, Doctoral Student / Dominik Windey, Doctoral Student

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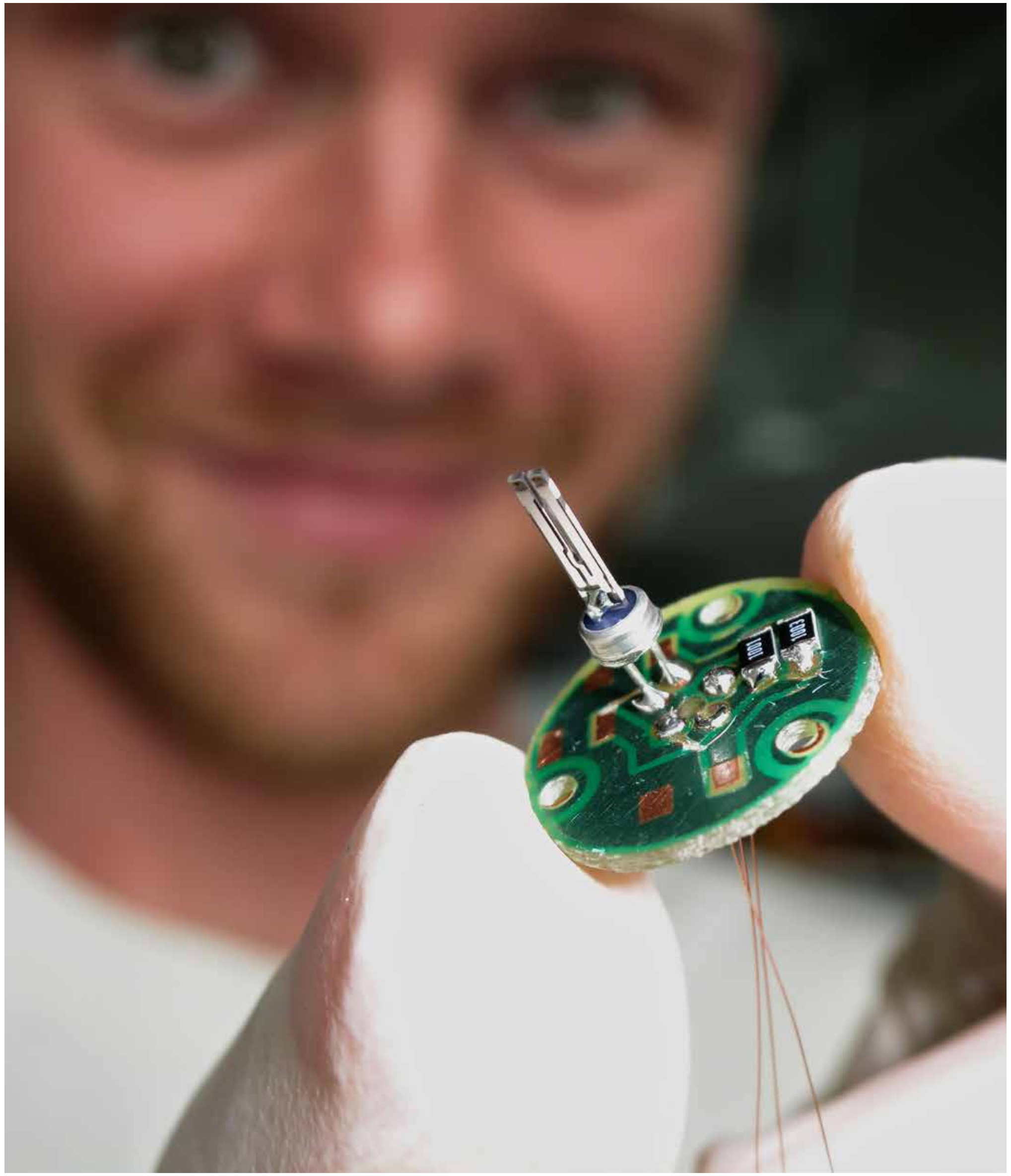


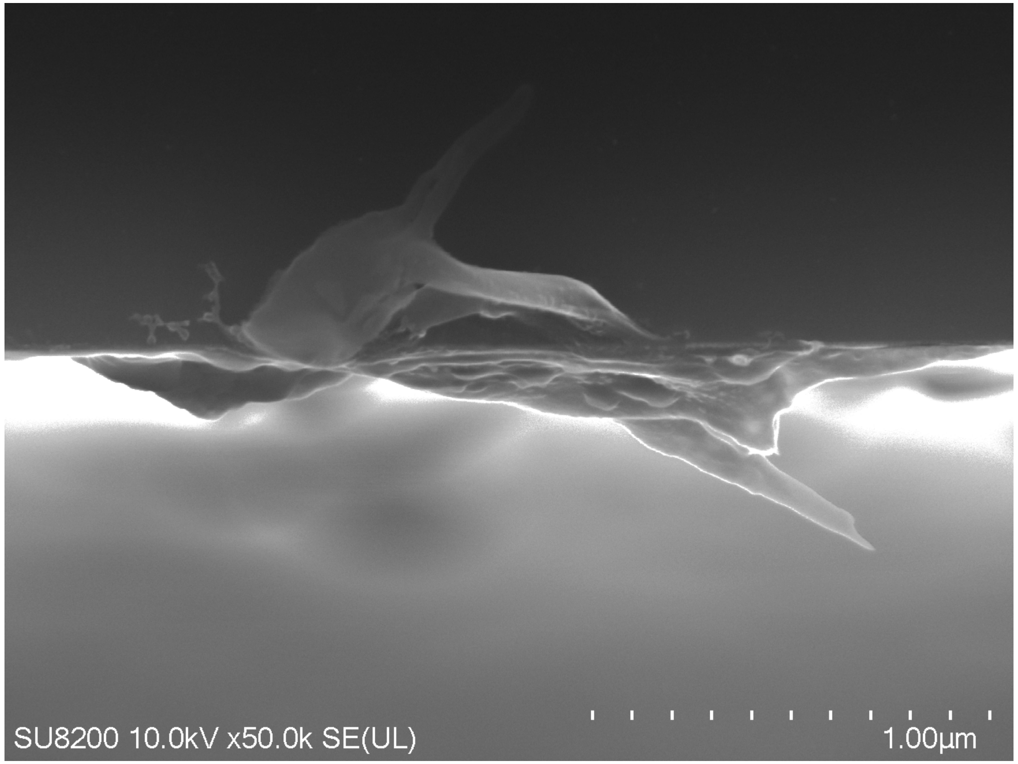
Turning small and simple things into something big

A quartz tuning fork shown in the photo is a tiny component present in almost every electronic clock. This common timing oscillator turns out to also be suitable for sensing extremely low forces and performing state-of-the-art scanning probe microscopy imaging, and has been utilized for that purpose by many research groups around the world. We use it for research on superconducting nanowire single-photon detectors – a novel light sensing technology with many promising applications.

In order to precisely "see" what is going on in the photon detection process, we need to use certain tricks to overcome the fundamental limits of resolution in optical imaging. We exploit unique properties of the so-called optical near-field. This technique requires the imaged object to be kept at a steady distance of about one millionth of a millimeter from the light source. For that, reliable sensing of extremely weak force is needed.

Since those few-millimeter sized quartz tuning fork crystals are very fragile, preparing one for an experiment without breaking it is quite an achievement. In the photo my smile indicates that this attempt was successful.

Name: Karol Luszcz
Position: ex Doctoral Student (recently finished)
Lab: Photonics Laboratory
Other team member: Eric Bonvin, Doctoral Student, Photonics Laboratory



3rd Prize

D-ITET
RESEARCH PHOTO COMPETITION
2019

Diving into the Unknown

Nearly all information we send out today is transmitted through optical wires in the form of light. Conversely, we create this information electronically, with our smartphones and computers. At some point, we have to translate from the electrical to the optical regime. Researchers have come up with a variety of devices that do that job, so called electro-optic modulators. However, the global demand for data traffic increases by ~60% per year, faster and smaller devices are needed.

At the Institute of Electromagnetic Fields, we combine new optical technologies with new photonic technologies. Our devices are nano-fabricated on optical chips, and currently the fastest and smallest in the world. Thus, we equip the data transmission infrastructure of tomorrow.

The depicted image is a scanning electron microscopy image of the cleaved edge of a nano-structured chip, 50.000X magnified. Instead of finding the feature of interest, I found a 2 µm long cat, seemingly diving from the chip in the top towards the vacuum below.

Name: Andreas Messner
Position: Doctoral Student
Lab: Institute of Electromagnetic Fields (IEF)

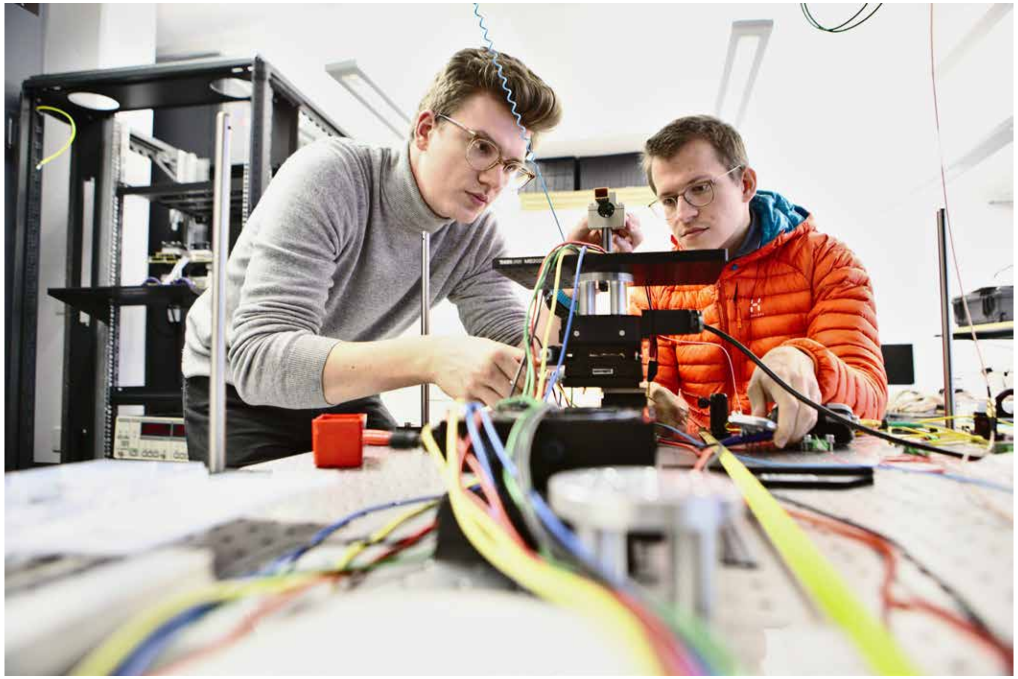
4th Prize

D-ITET RESEARCH PHOTO COMPETITION 2019

Pick your wavelengths: Color diversity and color purity of low toxicity quantum dot emitters

Semiconductor colloidal nanocrystals with luminescent properties (also known as quantum dots) are particularly interesting for the solid-state lighting and bio-medical applications. The color, which nanocrystals emit, is typically adjusted by their size, ranging from several 100s to several 1000s of atoms. Furthermore, if several elements can be combined in the nanocrystal structure, the color wavelength, purity, and efficiency all become a function of nanocrystal composition. The photo shows colloidal solutions of three-component I-III-VI group semiconductor nanocrystals, luminescing under the UV light illumination. Accurate and programmable engineering of such multicomponent quantum dots allows a selection of optimal size and optimal composition of nanocrystals for specific emission wavelength, ranging from yellow to near-infrared spectral region. With surface protection, the luminescence efficiency of 70-80% is achieved.

Name: Olesya Yarema
Position: Postdoc
Lab: Materials and Device Engineering Group, Institute for Electronics
Other team members: Maksym Yarema, Senior Scientist, Institute for Electronics / Vanessa Wood, Head of Institute, (Institute for Electronics)



Faster than fiber?

Tobias and Yannik are setting up an antenna for a new transmission experiment, which aims at breaking the speed barrier of today's wireless communications by improving their speed by 10,000 times.

For this scope, we will use extremely high frequency signals, with wavelengths in the sub-millimeter wave range – about one hundredth of those used in our smartphones. This requires a very precise alignment, which can be achieved with the black micrometric alignment stages visible in the center of the image.

The internet of today is based on a global network of optical fiber cables that connect the entire planet. These fibers can transmit hundreds of terabits per second (in other words, the contents of more than a hundred blu-ray movies in one second). At the same time, everyone wants to access the internet wirelessly, using mobile devices, smartphones, or tablets – we expect more than 20 billion internet connected devices by 2020 – without using any cable. However, the speed of current wireless communications systems is more than 10,000 times lower than that of the fiber, creating a real "wireless bottleneck" toward the increase of speed for future wireless communications.

The aim of our project is to demonstrate wireless transmission systems that are 10,000 faster than state of the art wireless connections. We will achieve that using signals with extremely high frequency – more than 100 times than today – and devices that are capable of directly converting light signals travelling in the optical fibers to high-speed wireless signals, and vice versa.

Name: Maurizio Burla
Position: Senior Researcher / Group leader
Lab: Institute of Electromagnetic Fields (IEF)
Other team members: Yannik Horst, Master's Student, (IEF) / Tobias Blatter, Master's Student, (IEF) / Yannick Salamin, Doctoral Student, (IEF) / Juerg Leuthold, Professor and Group Leader, (IEF)

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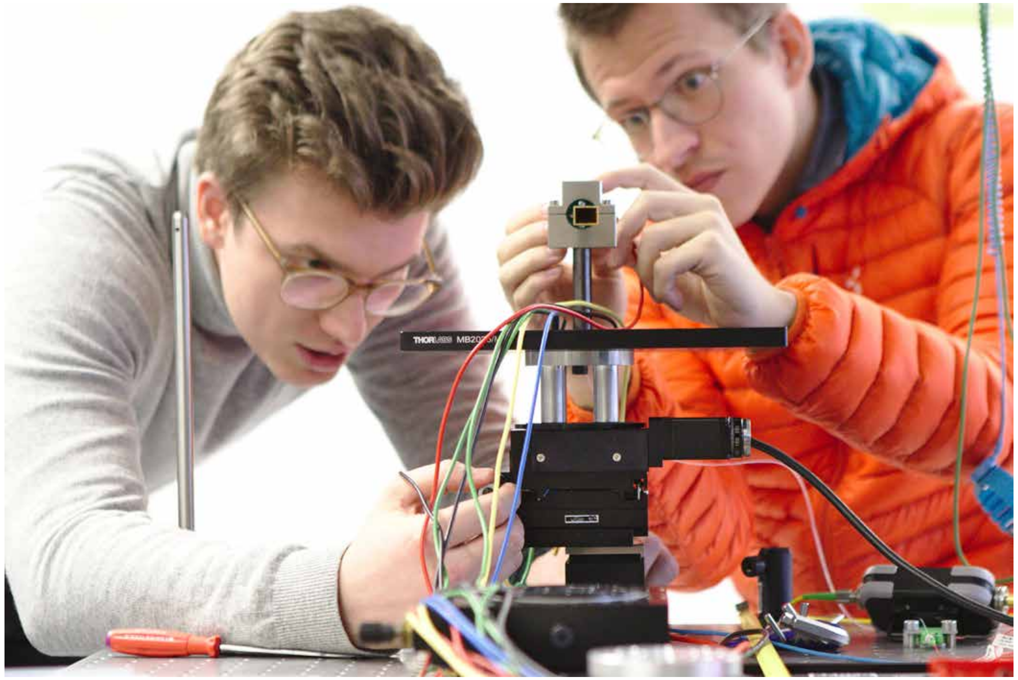

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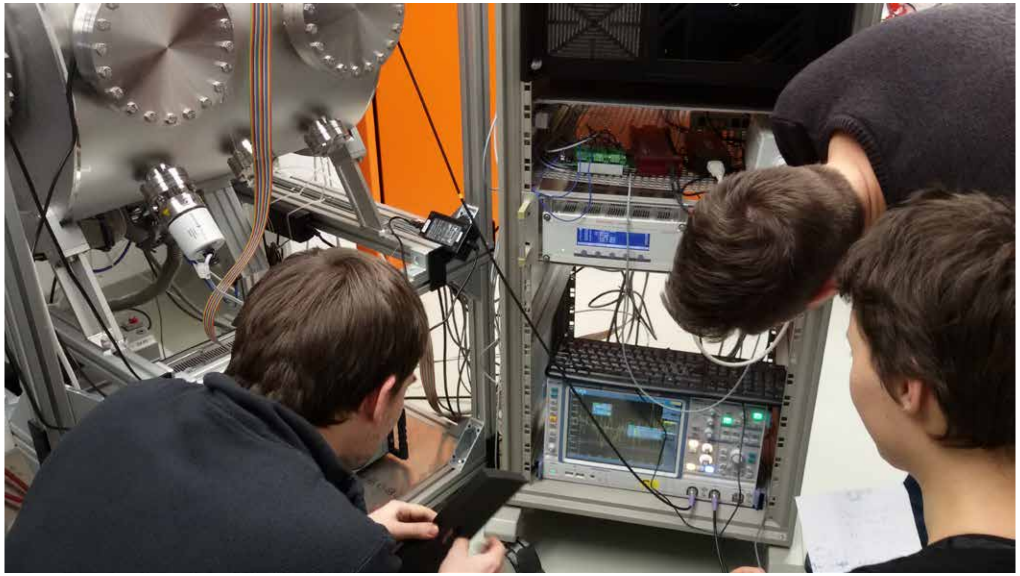
D-ITET RESEARCH PHOTO COMPETITION 2019



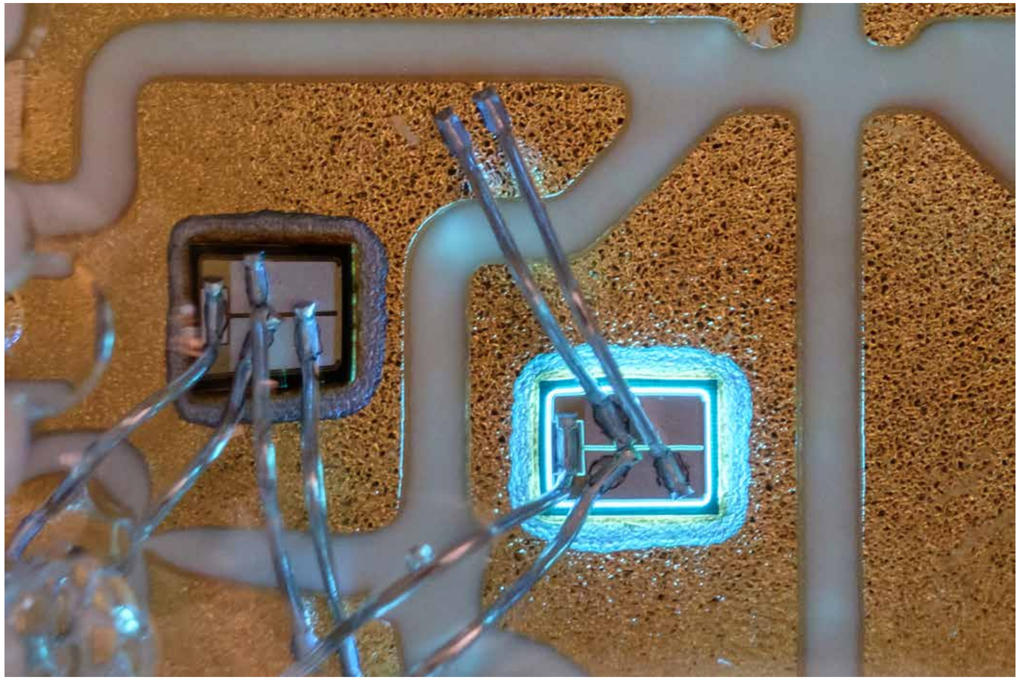
Who decided to put the oscilloscope down there

In science, there is the occasional measurement where everyone gathers around and stares in awe. There should be a smooth curve, instead we saw randomness. Pascal saw the randomness upside-down. Later, we organized ourselves a screen and put it at the top.

This machine is, when it shows smooth curves, an excellent new experiment for investigating gas parameters. The steel vessel on the left contains the measured gas. The oscilloscope captures the waveforms on nano-second timescale.

Name: Juriy Pachin
Position: Doctoral Student
Lab: High Voltage Laboratory (HVL)
Other team members: Andreas Hösl, Doctoral Student, (HVL) / Alise Chachereau, Doctoral Student, (HVL)

D-ITET RESEARCH PHOTO COMPETITION 2019



Silicon carbide transistor becomes an LED

The photo shows two power transistor chips (MOSFETs) made from silicon carbide, a new and promising material for efficient power conversion. The chips are mounted on a gold plated copper-ceramic substrate, connected with aluminium wires and covered in a transparent gel. The left transistor is switched on and conducts current invisibly. The right one is switched off and conducting current like a diode. This results in photoemission, similar to a light emitting diode (LED). The key property of the material, its wide bandgap, becomes visible in the blue color of the light.

As the MOSFET is not a good LED, the photo needed to be taken with long exposure time (2 s). The chips measure 2 mm * 3 mm, the whole photo shows 17 mm * 11.3 mm. The devices pictured are rated for 900 V and 36 A (theoretically 32 kW, 4.8 GW/m^2).

Name: Thomas Ziemann
Position: Doctoral Student
Lab: Advanced Power Semiconductor Lab (APS)

1st Prize

D-ITET
RESEARCH
PHOTO
COMPETITION
2019

Spark(l)ing sound: The symbolic power of musical Tesla transformers

When Nicola Tesla (1856-1943) invented the transformer bearing his name, he arguably did not anticipate that it would someday be used to play music. The musical Tesla transformer is the product of merging a tried and tested device from the dawn of electrical engineering with a more recent invention: power semi-conductor switching devices. It thus stands symbolically for fruitful outcomes of such "technology mergers". It even mirrors part of the current research on new electrical energy conversion systems ("Solid State Transformers") which combine the principle of electrical energy transfer by magnetic coupling with the flexibility and speed of digitally controlled power semi-conductor switches.

These approaches rise new challenges that encourage collaborations between engineers and researchers with different backgrounds. At D-ITET, the collaboration between the Power Electronics Systems Laboratory and the High Voltage Laboratory on the insulation design of Solid-State Medium-Voltage Transformers is a fruitful example of such an interdisciplinary project.

The musical Tesla coil shown in the picture generates an alternating voltage of nearly half a million volts and throws meter-long lightning bolts to the tune of your favorite composer. It is a team effort: more than two dozen electrical engineering students have contributed during guided projects at the High Voltage Laboratory. Thanks for your commitment!

Name: Raphael Färber
Position: Doctoral Student
Lab: High Voltage Laboratory (HVL)

D-ITET
RESEARCH PHOTO COMPETITION
2019

#ShapeTheGreenFutureWithSolarBox

Imagine that the sun is giving you 10 Watts of power, but you can only make use of 5 Watts, because your energy conversion process is very lossy. With presented Solar Box converter developed at the Power Electronic Systems Laboratory at ETH Zurich, you're looking at the future: a power electronic converter that interfaces the solar power generation with the low-voltage consumer grid with an efficiency of 99.35%. Highly efficient energy conversion enables to maximize the use of the sustainable energy that we are getting from the sun. Finally, thanks to the very compact construction of the Solar Box, not only as little power as possible is lost from the moment that sun ray hits the solar panel until the energy is consumed, but also can be easily integrated with the panels.

Name: Jon Azurza Anderson
Position: Doctoral Student
Lab: Power Electronic Systems Laboratory (PES)
Other team member: Piotr Czyz, (PES)

34
Energy

4th Prize

D-ITET
RESEARCH PHOTO COMPETITION
2019

Tiny devices for a big challenge

Fighting climate change is one of the biggest challenges of our generation and requires the transition towards renewable energies. Their volatile infeed drastically impacts the grid operation resulting among others in undesirable voltage fluctuations.

In our research we investigate hybrid transformers which combine an efficient conventional transformer and a flexible power electronic converter ensuring a constant grid voltage level.

The picture features a 100kVA hybrid transformer prototype and contrasts the attributes of the two parts: the huge and robust transformer represented by its high voltage isolators in the background and the converter with its tiny and comparatively sensitive semiconductor switches in the foreground. The focus is on our tiny worker highlighting a state-of-the-art Gallium Nitride switch applied in this prototype. In contrast to converters with conventional Silicon switches (behind the worker), much more efficient and compact designs are achievable.

Many tiny steps of many (tiny) workers bring us closer to a CO2 free energy generation!

Name: Johannes Burkard
Position: Doctoral Student
Lab: Laboratory for High Power Electronic Systems (HPE)

D-ITET
RESEARCH
PHOTO
COMPETITION
2019

What is this noise? – Investigating the environmental impact of overhead lines

While the share of fluctuating renewable energy is rapidly increasing world-wide, the existing transmission grid needs reinforcements to cope with the increase in generation as well as the increasing distance between generation and consumption. However, the public acceptance for new transmission lines is usually low, with objections causing significant delays and challenging the system stability. The main drivers for this objection is the environmental impact of transmission lines, including electric and magnetic fields at ground as well as corona discharges causing an audible noise.

In order to ensure the public acceptance for reinforcement projects of the transmission grid, it is therefore crucial to predict these effects accurately and develop new methods to reduce them to an acceptable minimum. In order to improve simulation models, we therefore go out in the field to observe the corona discharges for different weather situations and conductor arrangements. This includes the observation of the discharges on the conductors using a UV-camera as well as recording of the noise levels within the corridor.

Name: Sören Hedtke
Position: Doctoral Student
Lab: High Voltage Laboratory (HVL)
Other team member: Pascal Bleuler, Doctoral Student, (HVL)

D-ITET RESEARCH PHOTO COMPETITION 2019

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Position: Doctoral Student
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Other team member: Pascal Bleuler, Doctoral Student, (HVL)

D-ITET
RESEARCH PHOTO COMPETITION
2019

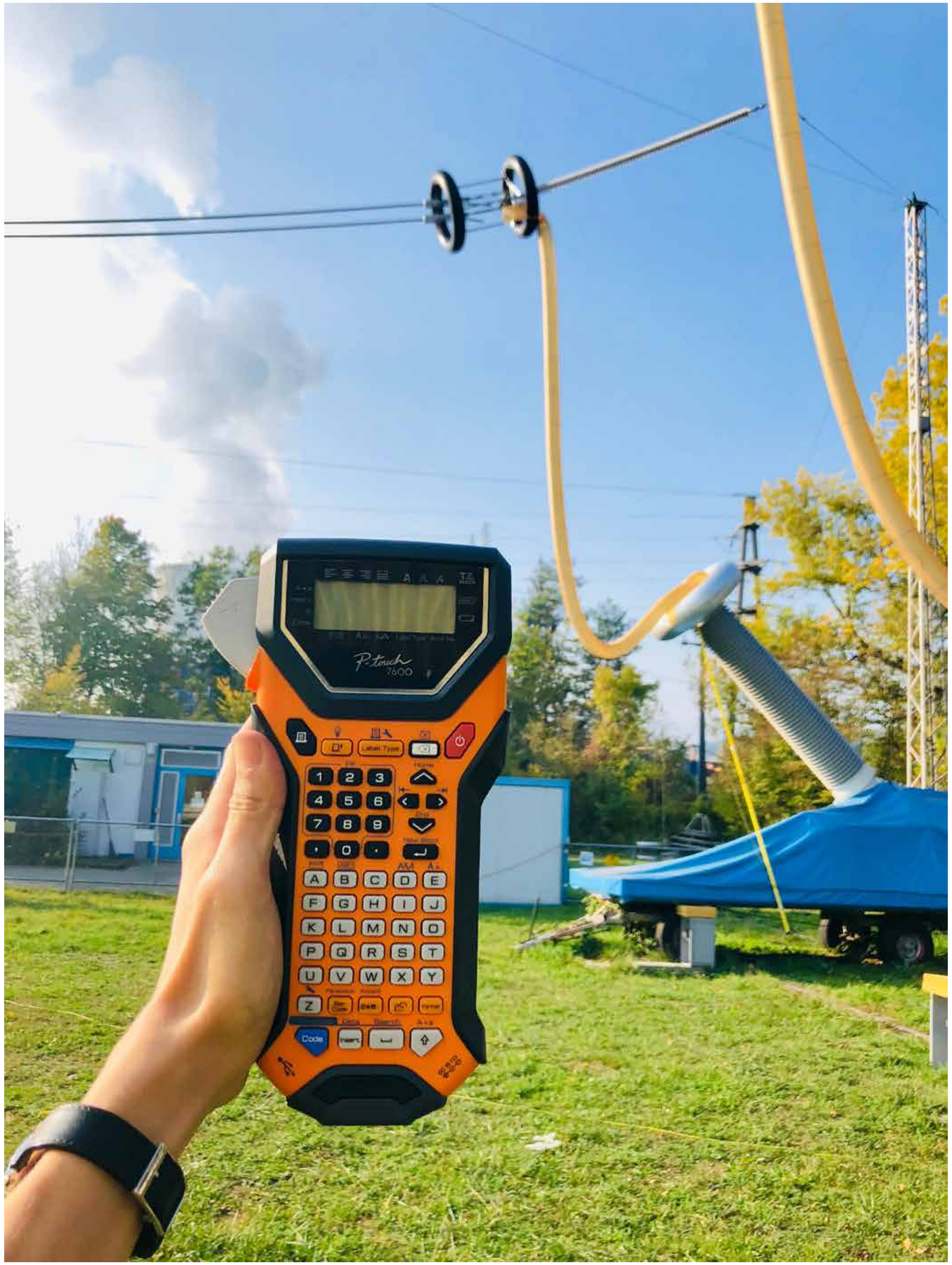
Setting up an outdoor overhead lines experiment

One of the main research axis at the high voltage lines is to think about the future of overhead transmission lines with the goals of increasing the grid's capacity and have it ready to deliver energy from clean and renewable sources to consumers with minimal losses.

Weather conditions such as rain, temperature and wind can have an effect on the ionic environment of overhead lines. To this end outdoor experiments with real life dimensions and climatic conditions are needed to complement our in lab measurements and simulations. Setting up such an experiment has its challenges. The researchers as well as the measurement equipment are exposed to the elements. Hundreds of meters of cable have to be joined and labelled correctly for everything to work some of them connected to devices on high potential, i.e. hundreds of kilovolts.

Name: Pascal Bleuler
Position: Doctoral Student
Lab: High Voltage Laboratory (HVL)
Other team member: Sören Hedtke, Doctoral Student, (HVL)

D-ITET RESEARCH PHOTO COMPETITION 2019



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Name: Pascal Bleuler
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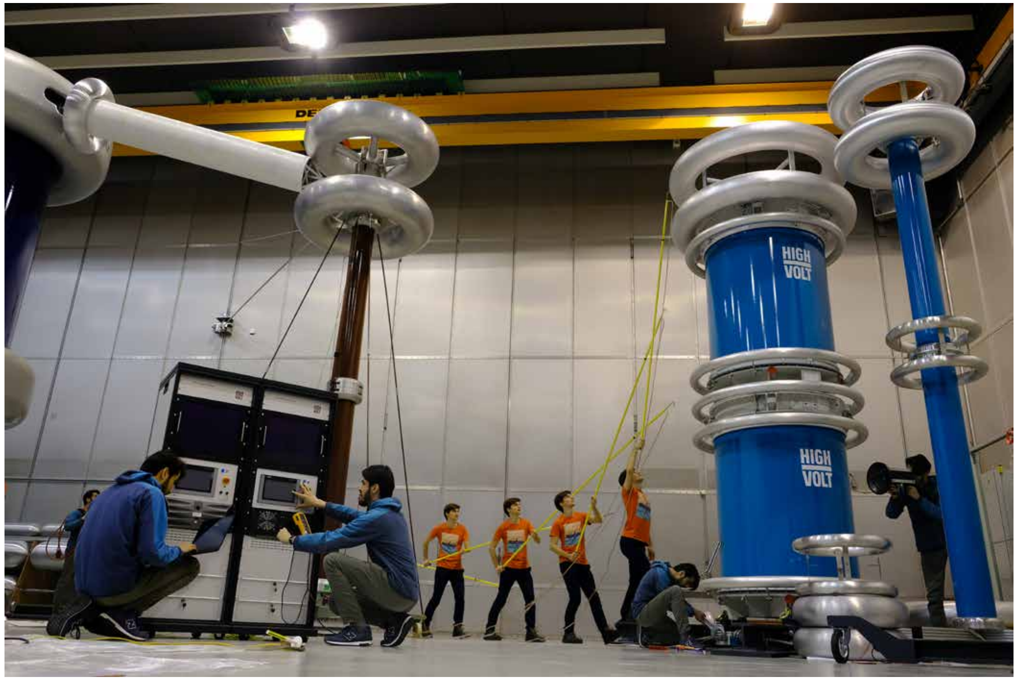
Lab: High Voltage Laboratory (HVL)
Other team member: Sören Hedtke, Doctoral Student, (HVL)

4th Prize

D-ITET RESEARCH PHOTO COMPETITION 2019



How do you handle a million volts?

High voltage engineering has its roots at the very beginning of the public utilization of electric energy in the 18th century. Since then, it has evolved dramatically. Today, we are capable of transmitting massive amounts of renewable energy with low losses over thousands of kilometers. However handling ultra-high voltages remains challenging to this day.

To push forward the boundaries of knowledge in energy transmission, special tools are required. A simple voltage source can be ten meters high, and needs to be shielded by specially shaped electrodes to avoid flashovers to the surrounding lab walls. Its output cannot simply be measured by a multi-meter or oscilloscope. Our group continuously develops new sophisticated measurement methods, control, and safety systems for its experiments. However, sometimes we still need traditional tools to fix and maintain – as almost everything when it comes to high voltage engineering, they are just a bit bigger than the usual.

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Position: Doctoral Students
Lab: High Voltage Laboratory (HVL)

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