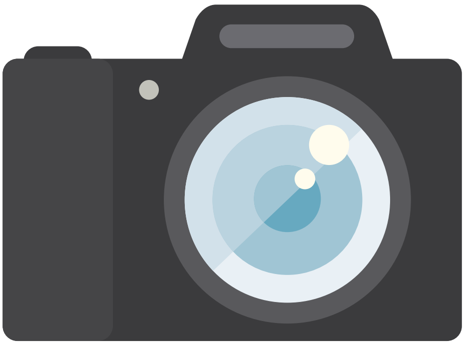
D-ITET
RESEARCH PHOTO COMPETITION
2016

D-ITET
RESEARCH PHOTO COMPETITION 2016

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 2016. Enjoy the collection of 82 great photos and stories that have been submitted by or researchers!

Prof. Christian Franck
Delegate for Communication and PR

D-ITET
RESEARCH PHOTO COMPETITION
2016

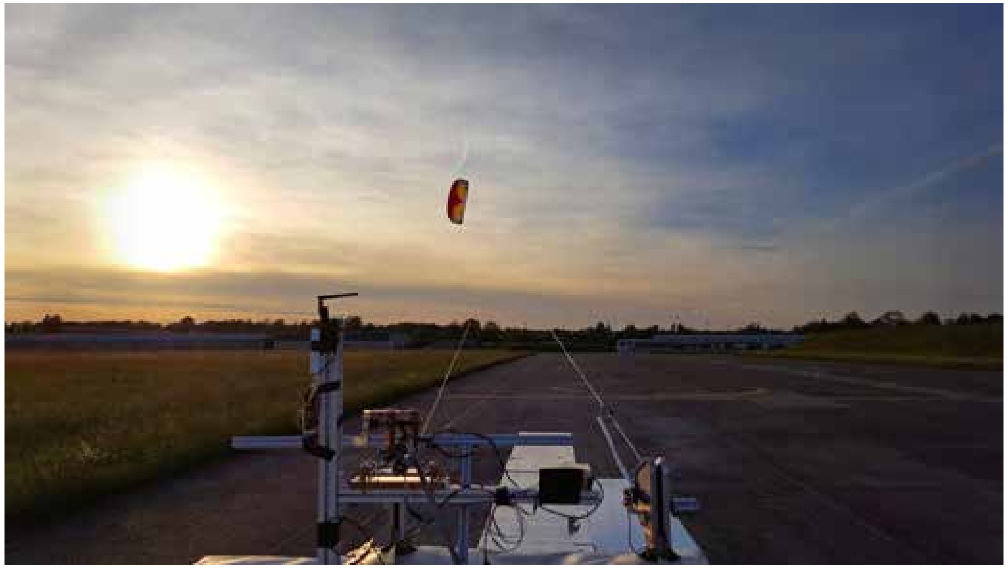
These are the winners of the D-ITET Research Photo Competition 2016:

1st prize:	Maurizio Burla (IEF), **Nr. 45**
2nd prize:	Martin Pfeiffer (HVL), **Nr. 74**
3rd prize:	Luc Dümpelmann (Photonics Lab), **Nr. 49**
4th prize:	Andrawes Al Bahou (IIS), **Nr. 42**
5th prize:	Jonas Steinhauser (IBT), **Nr. 38**
	Yvonne Stürz (IfA), **Nr. 27**
	Stefan Sommer (IBT), **Nr. 37**

Special Prizes

«Technology»:	Paul Beuchat (IfA), **Nr. 02**
	Marcel Schuck (PES), **Nr. 76**
	Alise Chachereau (HVL), **Nr. 68**
«Team»:	Hayko Riemenschneider (CVL) & team, **Nr. 21**
«Wildlife»:	Prof. Amos Lapidoth (ISI), **Nr. 12**

D-ITET RESEARCH PHOTO COMPETITION 2016

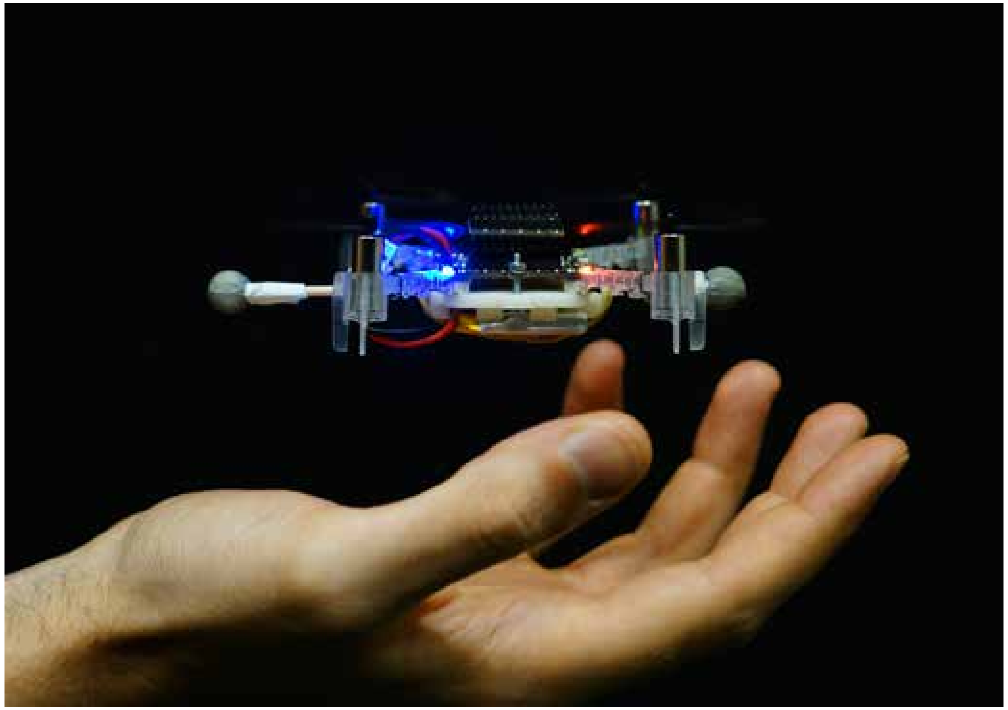


Exploring new horizons for kite power

The image shows a foil kite flying at sunset. The photo was taken on the Dubendorf airfield during a tow test where an Airborne Wind Energy generator is towed by a truck to generate desired relative wind conditions. The kite is tethered to a motorised ground station on the vehicle and is controlled using real-time measurement. We apply system theory to model and control the kite behavior based on the obtained measurement data. The image illustrates how Airborne Wind Energy generators provide alternative to traditional wind turbines that is less invasive to its surroundings.

Airborne Wind Energy systems harvest wind energy by exploiting the aerodynamic forces generated by autonomous tethered wings, flying fast in crosswind conditions. This technology is able to reach higher altitudes than conventional wind turbines, where the wind is generally stronger and more consistent, while at the same time reducing the construction and installation costs of the generator.

Name: Eva Ahbe
Position: PhD Student
Lab: Automatic Control Laboratory (IfA)
Other team member: Tony Wood, PhD Student, (IfA)



What came first, localization or autonomy?

The answer, of course, is both and neither. As robots begin to contribute more and more to the quality of our everyday life, the aspects of autonomous decision making, and knowing one's position in the world, needs to be researched in synergy. We therefore aim at further developing cutting edge technologies for both of these aspects: For the demonstration of autonomous decision making, we have the nano-quadcopters, the CrazyFlies, where one of them is shown in the photo. It carries the latest in sensing and computing hardware, and represents an autonomous flying robot that is inherently challenging to control and awe-inspiring to gaze at. Our goal is to have a swarm of CrazyFlies making decisions on their own, all by communicating with the others to cooperatively tackle a task such as flying in formation. However, in order to ensure their autonomy, we also work on algorithms to improving their abilities of precise localization, using Ultra-Wide-Band technology.

Name: Paul Beuchat
Position: PhD Student
Lab: Automatic Control Laboratory (IfA)
Other team members: Yvonne Stürz, PhD Student, (IfA) / Cyrill Frei, Master Student, (IfA)

Special prize «Technology»

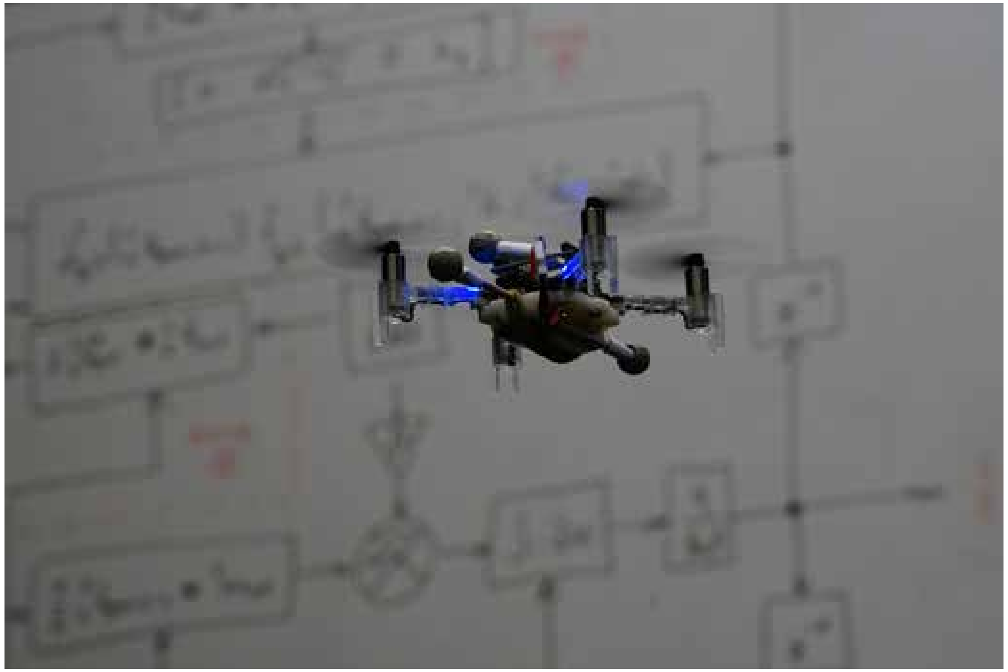
D-ITET
RESEARCH PHOTO COMPETITION
2016

What came first, localization or autonomy?

The answer, of course, is both and neither. As robots begin to contribute more and more to the quality of our everyday life, the aspects of autonomous decision making, and knowing one's position in the world, needs to be researched in synergy. We therefore aim at further developing cutting edge technologies for both of these aspects: For the demonstration of autonomous decision making, we have the nano-quadcopters, the CrazyFlies, where one of them is shown in the photo. It carries the latest in sensing and computing hardware, and represents an autonomous flying robot that is inherently challenging to control and awe-inspiring to gaze at. Our goal is to have a swarm of CrazyFlies making decisions on their own, all by communicating with the others to cooperatively tackle a task such as flying in formation. However, in order to ensure their autonomy, we also work on algorithms to improving their abilities of precise localization, using Ultra-Wide-Band technology.

Name: Paul Beuchat
Position: PhD Student
Lab: Automatic Control Laboratory (IfA)
Other team members: Yvonne Stürz, PhD Student, (IfA) / Cyrill Frei, Master Student, (IfA)

D-ITET RESEARCH PHOTO COMPETITION 2016

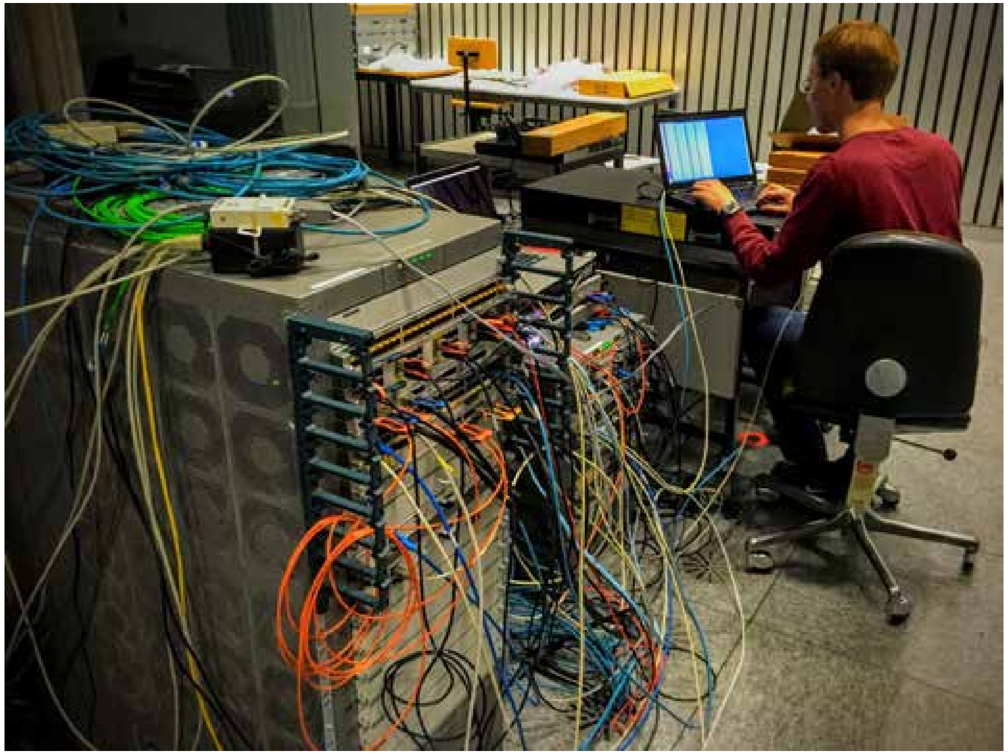


What came first, localization or autonomy?

The answer, of course, is both and neither. As robots begin to contribute more and more to the quality of our everyday life, the aspects of autonomous decision making, and knowing one's position in the world, needs to be researched in synergy. We therefore aim at further developing cutting edge technologies for both of these aspects: For the demonstration of autonomous decision making, we have the nano-quadcopters, the CrazyFlies, where one of them is shown in the photo. It carries the latest in sensing and computing hardware, and represents an autonomous flying robot that is inherently challenging to control and awe-inspiring to gaze at. Our goal is to have a swarm of CrazyFlies making decisions on their own, all by communicating with the others to cooperatively tackle a task such as flying in formation. However, in order to ensure their autonomy, we also work on algorithms to improving their abilities of precise localization, using Ultra-Wide-Band technology.

Name: Paul Beuchat
Position: PhD Student
Lab: Automatic Control Laboratory (IfA)
Other team members: Yvonne Stürz, PhD Student, (IfA) / Cyrill Frei, Master Student, (IfA)

D-ITET RESEARCH PHOTO COMPETITION 2016



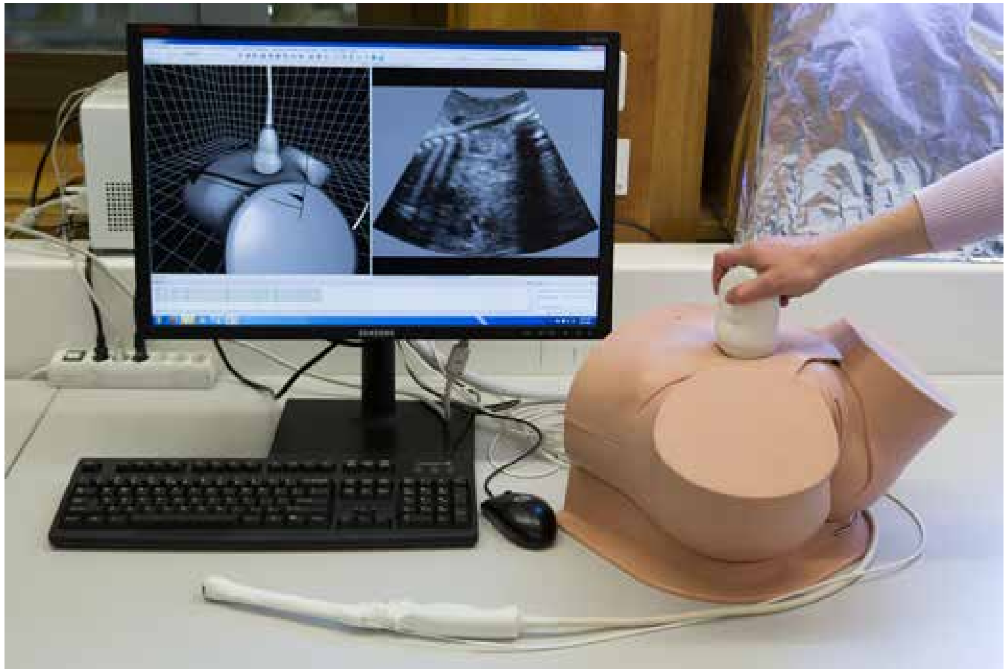
Getting the gist of all the clutter

Even a small computer network can already be complicated to correctly configure, analyze and debug. Beyond that, in large enterprise networks we are not only faced with hundreds of devices, but also with high traffic volumes which makes it hard to reason about the network and its state. Traditional network analyzing tools are very limited in their scope and cannot provide comprehensive views of the entire network as they rely on aggregated statistics and sampled traffic traces. In our research, we try to improve existing, deployed analysis solutions by employing smart "hacks".

Due to the ossification of computer networks, the resulting high costs in hardware upgrades and network downtime, we put a high emphasis on deployability in already existing networks. This is why we not just come up with new techniques, but also put our ideas to test in a real network consisting of two enterprise-scale routers as pictured in this photograph.

Name: Rüdiger Birkner
Position: PhD Student
Lab: Networked Systems Group (TIK)
Other team member: Tobias Bühler, Research Assistant, (TIK)

D-ITET RESEARCH PHOTO COMPETITION 2016



UltraVR – ultrasound imaging simulation for virtual reality training

Ultrasound is a low-cost, non-ionizing, interactive imaging modality, used commonly in clinics as an invaluable tool for screening, diagnostics, and therapy guidance. However, its image formation physics and interactive nature makes it substantially user-dependent, for instance some pathology diagnosed by one sonographer may be missed by another due to poor transducer navigation or image interpretation. Therefore, ultrasound examinations require a high level of expertise, involving several technical and practical skills, which usually require years to reach a sufficient level of competence. In particular in obstetrics and gynecology (OB/GYN), deliberate practice is often limited by the unavailability of patients with rare clinical findings. In-vivo training opportunities of navigation skills with volunteers for educational and residency training programs are also limited by the discomfort involved, e.g. in transvaginal examinations. Existing ultrasound training systems lack image realism, prohibiting the training of image interpretation and limiting the training of navigation skills. We aim at developing virtual-reality simulators for ultrasound training. As shown in the image, in such a life-like simulation, medical trainees shall manipulate a (mock) transducer over a (mock) torso while watching the simulated image scenery on a (simulated ultrasound) screen and will be judged by (computed) objective metrics.

Name: Barbara Flach
Position: Postdoc
Lab: Computer Vision Lab (CVL)
Other team members: Orcun Göksel, Professor, (CVL) /
Maxim Makhinya, Software Engineer, (CVL)

D-ITET RESEARCH PHOTO COMPETITION 2016

Urban undergrowth

Energy efficiency gains of electric, heating and cooling systems and networks are of paramount importance to climate change mitigation. In large decentralized energy networks, efficiency gains can potentially be achieved by coordinating connected sources, consumers and storage devices of different energy carriers (such as heating, cooling, natural gas, electricity and hydrogen). The photograph depicts parts of the ductwork in the energy hub of NEST, an experimental building. The NEST energy hub aims to provide a research platform to explore coordination and control mechanisms.

In urban areas, the energy infrastructure is entwined with the buildings like ground vegetation (bot. undergrowth) with trees. Recent research has shown that the undergrowth connects the trees and plants and provides ways of commination and matter exchange. Undergrowth and renewable energy resources can only prosper with sufficient sunlight. As long as they shine green, energy is abundant and can be exchanged through both, the biological as well as the mechanical network.

Name: Marc Hohmann
Position: PhD Student
Lab: Automatic Control laboratory (IfA)

D-ITET
RESEARCH
PHOTO
COMPETITION
2016

Responsive and reliable wireless communication to protect human lives in alpine regions

Under the steady watch of the Weisshorn, in Valais, an imminent rockslide is endangering the village of Randa. Thus, earlier this spring, our research group, from TIK, installed an additional GPS localization sensor (the white dome on top of the pole), on top of the soon-to-fall rock wall (everything right to the breach). It is autonomously powered by a solar panel, and continuously communicating data through wireless communication. This is a rare occasion of collecting high quality data on a major rock fall, a natural phenomenon which is typically difficult to predict.

The PermaSense project develops, deploys and operates wireless sensing systems customized for long-term autonomous operation in high-mountain environments, with the double objective of a better understanding of slope instability and real-time monitoring activities, in collaboration with public authorities, to anticipate rock falls and prevent dramatic accidents and the loss of human lives.

Name: Romain Jacob
Position: PhD Student
Lab: Computer Engineering and Networks Laboratory (TIK)
Other team member: Dr. Jan Beutel, Senior Scientist, (TIK)

D-ITET
RESEARCH PHOTO COMPETITION
2016

Responsive and reliable wireless communication to protect human lives in alpine regions

Under the steady watch of the Weisshorn, in Valais, an imminent rockslide is endangering the village of Randa. Thus, earlier this spring, our research group, from TIK, installed an additional GPS localization sensor (the white dome on top of the pole), on top of the soon-to-fall rock wall (everything right to the breach). It is autonomously powered by a solar panel, and continuously communicating data through wireless communication. This is a rare occasion of collecting high quality data on a major rock fall, a natural phenomenon which is typically difficult to predict.

The PermaSense project develops, deploys and operates wireless sensing systems customized for long-term autonomous operation in high-mountain environments, with the double objective of a better understanding of slope instability and real-time monitoring activities, in collaboration with public authorities, to anticipate rock falls and prevent dramatic accidents and the loss of human lives.

Name: Romain Jacob
Position: PhD Student
Lab: Computer Engineering and Networks Laboratory (TIK)
Other team member: Dr. Jan Beutel, Senior Scientist, (TIK)

D-ITET
RESEARCH
PHOTO
COMPETITION
2016

Responsive and reliable wireless communication to protect human lives in alpine regions

Under the steady watch of the Weisshorn, in Valais, an imminent rockslide is endangering the village of Randa. Thus, earlier this spring, our research group, from TIK, installed an additional GPS localization sensor (the white dome on top of the pole), on top of the soon-to-fall rock wall (everything right to the breach). It is autonomously powered by a solar panel, and continuously communicating data through wireless communication. This is a rare occasion of collecting high quality data on a major rock fall, a natural phenomenon which is typically difficult to predict.

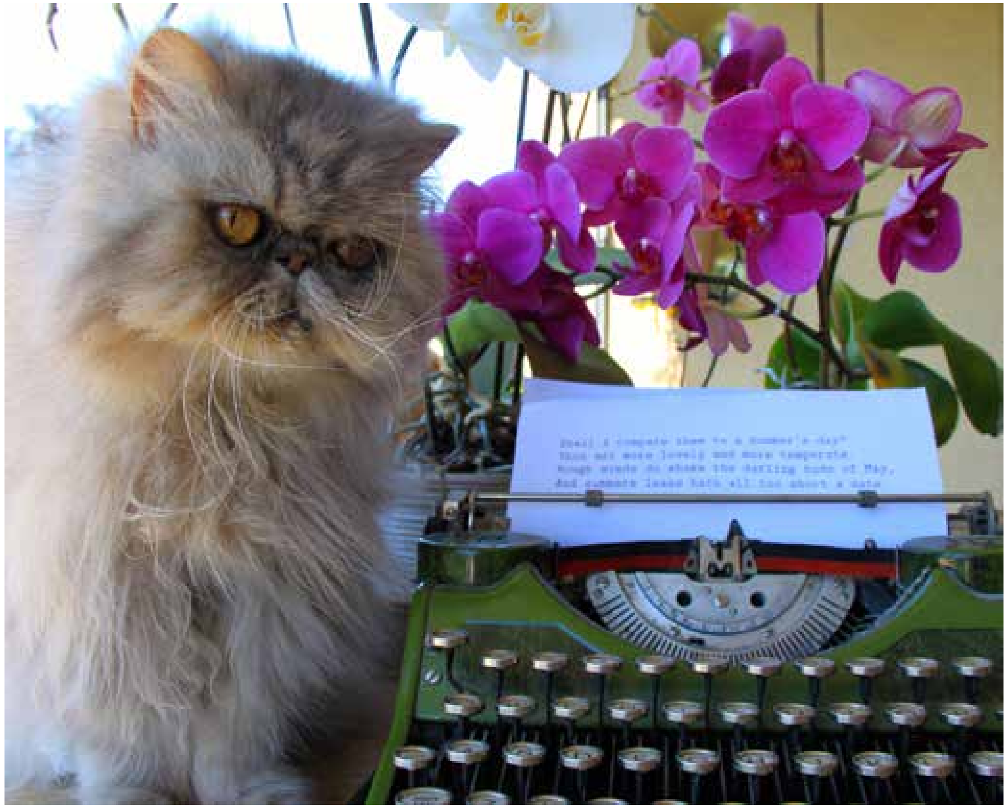
The PermaSense project develops, deploys and operates wireless sensing systems customized for long-term autonomous operation in high-mountain environments, with the double objective of a better understanding of slope instability and real-time monitoring activities, in collaboration with public authorities, to anticipate rock falls and prevent dramatic accidents and the loss of human lives.

Name: Romain Jacob
Position: PhD Student
Lab: Computer Engineering and Networks Laboratory (TIK)
Other team member: Dr. Jan Beutel, Senior Scientist, (TIK)

Your personal cameraman

We are working on a device that autonomously detects, tracks and films moving objects. The camera rotates in 360 degrees and moves in roll-pitch in 180 degrees. It can be used to film lectures, presentations and project meetings, always centering the speaker or any other identifiable object.

Name: Nikolaos Kariotoglou
Position: Postdoc
Lab: Automatic Control Laboratory (IfA)
Other team member: Reto Hofmann, Research Assistant, (IfA)



The Rényi Entropy Rate of English and Lapidoth's cat

The digital storage and transmission of text files, audio clips, or pictures require that they first be described using zeros and ones. This description should be as succinct as possible in order to reduce the storage requirements and the transmission time. That is what data compression is all about. How well a source can be compressed is determined by its Shannon Entropy Rate. For Shakespeare's English this quantity can be estimated using recurrence times, i.e., by seeing how long it takes for a "monkey on a typewriter" to produce a Shakespeare sonnet. But a finer analysis of data compression – one that accounts for rare texts that necessitate long descriptions – requires more than the Shannon Entropy: it calls for the source's Rényi Entropy Rate. How to estimate it is what this project is all about.

Incidentally, cats apparently don't like to type. Oh, and Schrödinger's was not a Persian ;-)

Name: Amos Lapidoth
Position: Professor
Lab: Signal and Information Processing Laboratory (ISI)

Special prize «Wildlife»

D-ITET
RESEARCH
PHOTO
COMPETITION
2016

Error-free communication, umbrellas, and feedback

Consider an umbrella whose handle and five ribs have unit length. Open the umbrella to the point where the maximum angle between the ribs is pi/2. Let u1, u2, u3, u4, u5 be the ribs and c be the handle, as vectors oriented away from their common point. Then u1,..., u5 is an orthonormal representation of C5." This is how Lovász's award-winning 1979 paper begins the derivation of the zero-error capacity of the pentagon channel. The zero-error capacity is the highest rate at which one can communicate over a channel if no errors whatsoever are allowed, not even those that occur exceedingly infrequently. Computing this capacity for general channels is one of the longest standing problems in Information Theory, and Lovász got his award for solving one of the "simplest" cases. The problem, however, becomes much more tractable in the presence of a feedback link from the channel output to the transmitter. For this scenario, the zero-error capacity was established by Shannon back in 1956. The present project extends Shannon's work to state-dependent channels, where the transmitter is revealed the state sequence in one of three different ways: strictly-causally, causally, or noncausally.

Name: Amos Lapidoth
Position: Professor
Lab: Signal and Information Processing Laboratory (ISI)
Other team member: Annina Bracher, PhD Student, (ISI)

D-ITET RESEARCH PHOTO COMPETITION 2016

Time-lapse

The autonomous miniature car is racing through a curve. To capture the motion of the car a sequence of pictures is taken, the sequence is then laid on top of each other to highlight how the car is driving. The six pictures show the car driving for about one second.

We derive novel control algorithms for autonomous driving, focusing on controlling the car at the handling limit. Self-driving cars are getting more popular, our research tries to make these cars safer by being able to control the car in extreme situations; for example an extreme maneuver could be used to avoid an accident. Furthermore, we work on algorithms that are safe by design so that accidents should not even occur.

Verifying that an autonomous car drives safely will be one of the big challenges for getting autonomous cars onto the street. Safe self-driving cars could in the future reduce traffic related deaths, help to get rid of traffic jams, and reduce CO_2 production.

Name: Alexander Liniger
Position: PhD Student
Lab: Automatic Control Laboratory (IfA)

D-ITET RESEARCH PHOTO COMPETITION 2016

The green flash

The autonomous miniature car is avoiding multiple cars standing on the track. To capture the motion of the car, we use a long exposure of 1 second. This results in a green trail, and nicely shows how the car avoids all the standing cars and drives safely out of the picture.

We derive novel control algorithms for autonomous driving, focusing on controlling the car at the handling limit. Self-driving cars are getting more popular, our research tries to make these cars safer by being able to control the car in extreme situations; for example an extreme maneuver could be used to avoid an accident. Furthermore, we work on algorithms that are safe by design so that accidents should not even occur.

Verifying that an autonomous car drives safely will be one of the big challenges for getting autonomous cars onto the street. Safe self-driving cars could in the future reduce traffic related deaths, help to get rid of traffic jams, and reduce CO_2 production.

Name: Alexander Liniger
Position: PhD Student
Lab: Automatic Control Laboratory (IfA)

D-ITET
RESEARCH
PHOTO
COMPETITION
2016

The blur of speed

The autonomous miniature car is racing through a chicane. A panning shot is used to capture the motion of the car, where the car is in focus and the rest of the image is blurred due to moving the camera with the car.

We derive novel control algorithms for autonomous driving, focusing on controlling the car at the handling limit. Self-driving cars are getting more popular, our research tries to make these cars safer by being able to control the car in extreme situations; for example an extreme maneuver could be used to avoid an accident. Furthermore, we work on algorithms that are safe by design so that accidents should not even occur.

Verifying that an autonomous car drives safely will be one of the big challenges for getting autonomous cars onto the street. Safe self-driving cars could in the future reduce traffic related deaths, help to get rid of traffic jams, and reduce CO2 production.

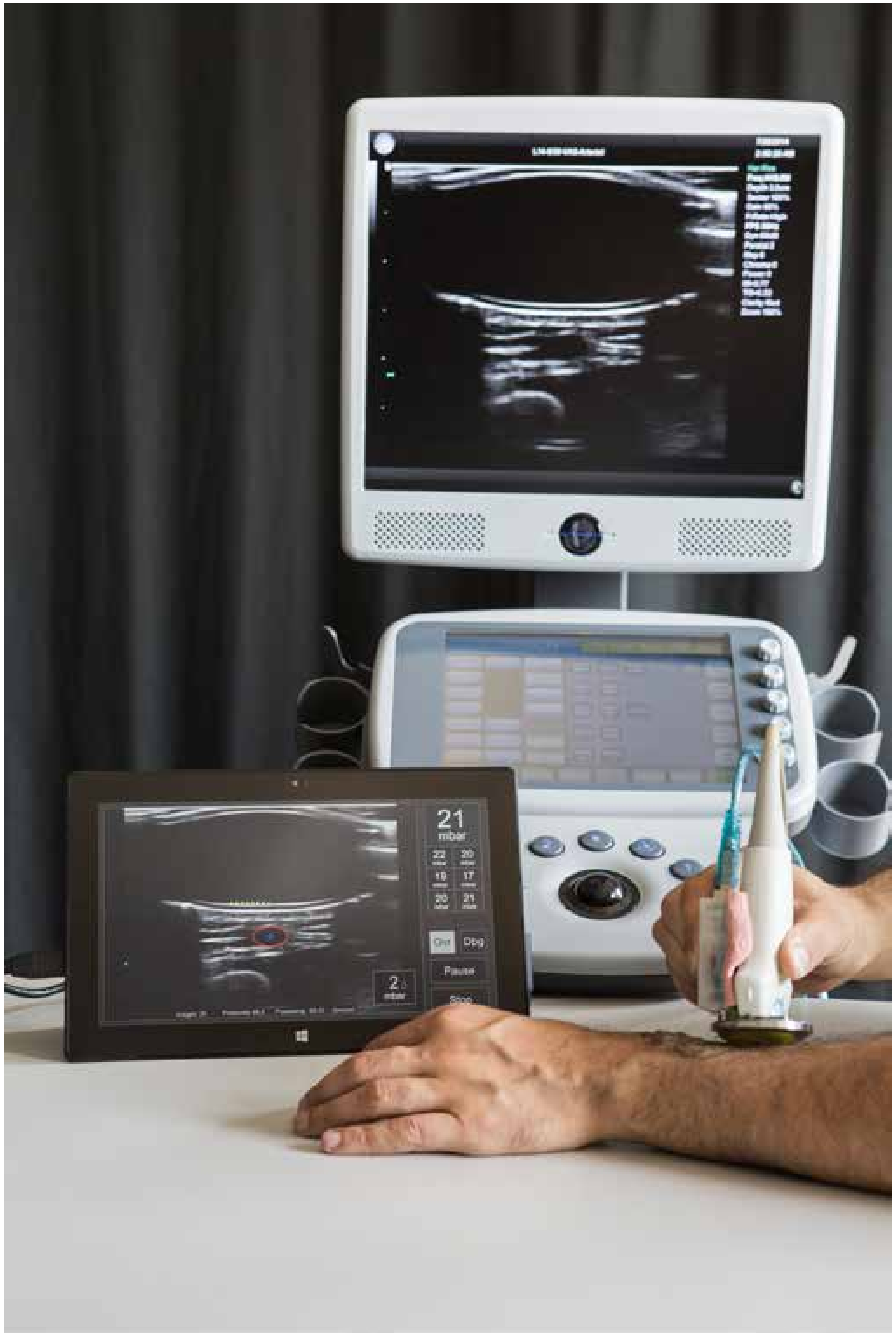
Name: Alexander Liniger
Position: PhD Student
Lab: Automatic Control Laboratory (IfA)

D-ITET RESEARCH PHOTO COMPETITION 2016

Air quality sensors commute to work by tram

Did you know that some of the trams in Zürich are not only carrying passengers but also air quality monitoring stations? As a part of the OpenSense (www.opensense.ethz.ch) research project we deployed sensor boxes on top of 10 trams in the city of Zürich. These boxes are roughly the size of a shoe box and contain various small and cheap gas sensors. You can see an example of such a box in the picture highlighted by the red circle. Our deployment allows us to measure the concentrations of highly toxic and harmful pollutants, such as ozone (O3), nitrogen dioxide (NO2), carbon monoxide (CO) and ultra-fine particles (UFP) with highly spatial and temporal resolution. Up to this date we have one of the largest openly available air quality dataset with over 150 millions sensor samples recorded all over the city of Zürich since 2011. Various research institutions already made use of this data to create detailed and accurate air quality maps.

Name: Balz Maag
Position: PhD Student
Lab: Computer Engineering Group (TEC)
Other team member: Dr. Zimu Zhou, Postdoc, (TIK)



D-ITET
RESEARCH PHOTO COMPETITION
2016

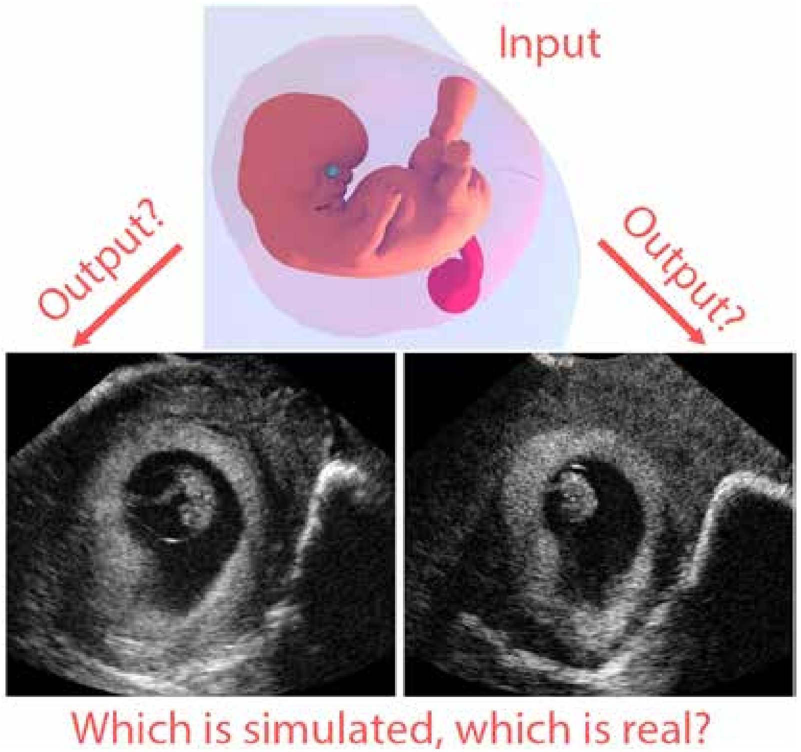
Soft touch on the arm to replace a catheter to the heart

Central venous pressure (CVP) information is crucial in various clinical situations, CVP measurement, however, requires catheterization, which is an impractical and costly procedure with related risk of complications. Peripheral venous pressure, which correlates with CVP under certain patient positioning, can be measured noninvasively using ultrasound via controlled compressions of a superficial vein. The picture presents the developed by us hardware-software-complex, that allows automatic acquisition of such non-invasive measurements in a matter of seconds without any discomfort or risks for the patient.

The prototype of the pressure-sensitive pouch, developed by our industrial collaborators, is attached to the ultrasound probe, seen on the bottom-right of the picture. The user is pushing on the vein in the forearm using the ultrasound probe and this pouch, the resulting ultrasound image can be seen in the ultrasound machine in the background. At the same time the image from the ultrasound machine is being captured by the tablet computer, that tracks the vessel (red circle in the middle of the tablet's screen) and performs the venous pressure computation (numbers in the right of the tablet's screen), all done in real-time. The entire procedure takes only 10-15 seconds, and it takes only few minutes for non-experts to learn how to perform the measurement (compared to timely, expensive and dangerous catheterization, which requires highly skilled personal).

Name: Maxim Makhinya
Position: Software Engineer
Lab: Computer Vision Lab (CVL)
Other team member: Orcun Göksel, Professor, (CVL)

D-ITET RESEARCH PHOTO COMPETITION 2016

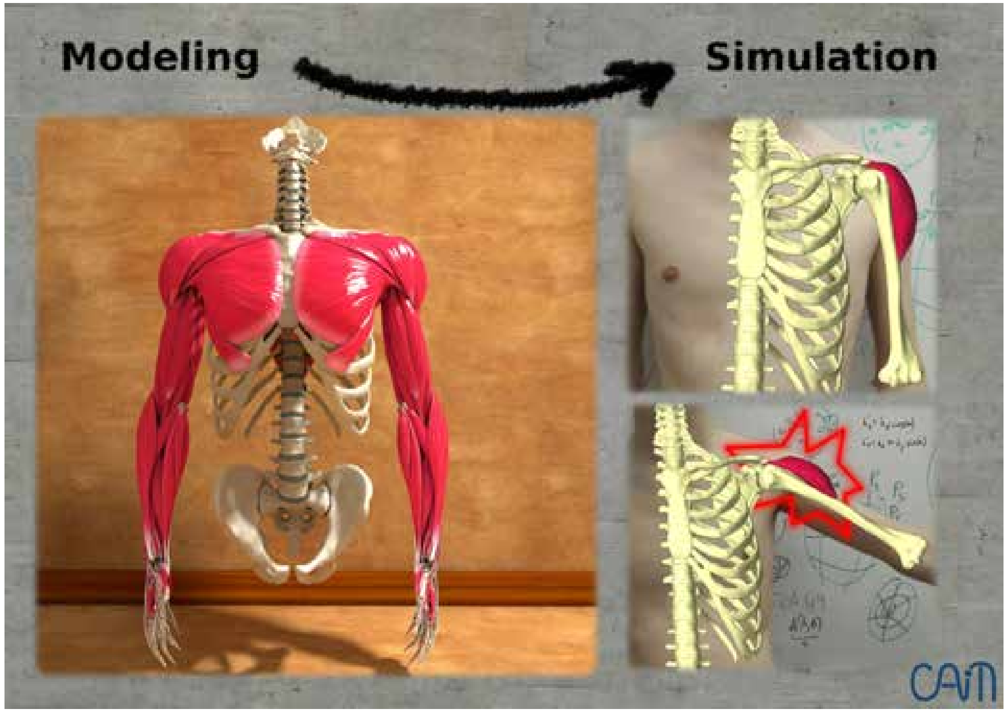


Ultrasound in virtual reality

Ultrasound is a radiation-free, low-cost, real-time, and hence a widely-used medical imaging modality. Interpreting ultrasound images is quite complex, requiring ample training. We have developed a system for computer-based training of ultrasound examinations using GPU rendering techniques (similarly to animated movies) for a realistic and real-time simulation of ultrasound physics and interaction in tissue. With this, standard as well as difficult scenarios including rare diseases can be simulated from 3D anatomical models in virtual-reality to train doctors. This image shows an ultrasound image of an embryo, as well as a simulated replica of a similar 3D scene. Fine details and rich texture of ultrasound images are successfully reproduced, and ultrasound artifacts such as shadows and bone reflections are realistically generated by our method in interactive times.

Name: Oliver Mattausch
Position: Postdoc
Lab: Computer Vision Lab (CVL)
Other team member: Orcun Goksel, Professor, (CVL)

D-ITET
RESEARCH
PHOTO
COMPETITION
2016



Biomechanical simulation of the shoulder

Our modeling approach will take advantage of medical images in order to estimate the geometric and biomechanical parameters of a subject, for example the volume of the muscles. The parameters found will be used to morph a generic model to a specific patient. The simulation of such model will reproduce what the patient is experiencing in reality, while highlighting the internal causes of the problems, thus improving the diagnosis. If the pathology requires a surgery, it would then allow to plan the surgery and find out its outcome beforehand, therefore improving the reliability of the procedure and the restoration of the patient's motor functions. The image is a representation of a generic model of the human upper limbs on the left, transitioning into a model of a patient on the right. The latter is overlaid to visualize the expected correspondence between reality and simulation, while displaying a sample of muscle contracting alongside with the movement.

Name: Fabien Péan
Position: PhD Student
Lab: Computer Vision Laboratory, Computer-assisted Application in Medicine (CAiM)
Other team members: Firat Ozdemir, PhD Student, (CAiM) /
Prof. Orçun Goeksel, Group Head, (CAiM)

D-ITET
RESEARCH
PHOTO
COMPETITION
2016

28 hours before the deadline – IT WORKS!

As computer scientist we work often in front of screens and there is little for people to see. This time the team all shared the same experience as Andras was happy to show his new method for 3D surface reconstruction works robustly on large city-wide datasets. It was many intense weeks before and the final results just finished mere 28 hours before one of our main conference submission deadlines (CVPR). The excitement speaks for itself!

The research (checkout www.varcity.eu) created a 3D surface for entire streets in mere seconds where previous research needed hours and heavy GPU-based calculations. For the first time one can create detailed reconstructions in almost no time. We use the results of this and following works to create large city-wide 3D surface models to understand the entire city of Zurich.

Name: Hayko Riemenschneider
Position: Postdoc Researcher / Team Leader
Lab: Computer Vision Lab (CVL)
Other team members: The VarCity Team: Prof. Luc Van Gool / Dr. Ralf Dragon / Dr. Junseok Kwon / Dr. Kenneth Vanhoey / Dr. Danda Pani Paudel / Andras Bodis-Szomoru / Dengxin Dai; Michael Gygli / Nikolay Kobyshev / Till Kroeger / Santiago Manen / Dr. Andelo Martinovic / Dr. Markus Mathias / Dr. Julien Weissenberg

Special prize «Team»

D-ITET
RESEARCH
PHOTO
COMPETITION
2016

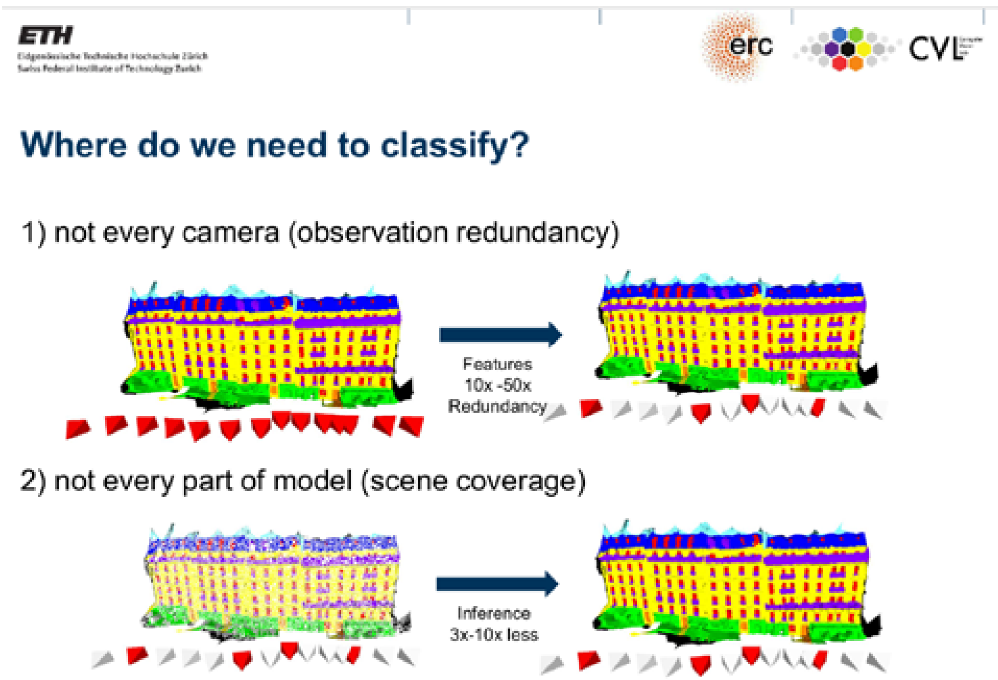
Hacking just like in the good old days

What does a professor do all day? Well, we finally have proof – he hacks secretly in the office of other people! This image was taken in February 2016 when Prof. Luc Van Gool felt the need to type and grabbed the keyboard to get to business!

The research (checkout www.varcity.eu) aims to create large city-wide 3D surface models to understand the entire city of Zurich. In particular, Prof. Luc Van Gool was rewriting some essential parts of a research text to help us get the benefits and ideas across to the scientific community – valuable input and he got right down to business in my office.

Name: Hayko Riemenschneider
Position: Postdoc Researcher / Team Leader
Lab: Computer Vision Lab (CVL)
Other team members: The VarCity Team: Prof. Luc Van Gool / Dr. Ralf Dragon / Dr. Junseok Kwon / Dr. Kenneth Vanhoey / Dr. Danda Pani Paudel / Andras Bodis-Szomoru / Dengxin Dai; Michael Gygli / Nikolay Kobyshev / Till Kroeger / Santiago Manen / Dr. Andelo Martinovic / Dr. Markus Mathias / Dr. Julien Weissenberg

D-ITET
RESEARCH
PHOTO
COMPETITION
2016



Efficiency for an entire city

As computer scientist we work often in front of screens and there is little for people to see. This image is a result of trying to understanding the details like windows, doors, balconies on the facade building – for the entire city of Zurich! The work proposed a way to reduce the computational redundancies from millions of images, usually more than 100 looking at the same scene to just the single one needed. And you know what? The results get even better when you remove all the redundancies. Focus is the word!

The research (checkout www.varcity.eu) created a semantic labeling of a 3D surface for entire streets in mere seconds where previous research needed hours due to the inherent redundancies from multi-view reconstruction. We use the results of this and following works to create large city-wide 3D surface models to understand the entire city of Zurich.

Name: Hayko Riemenschneider
Position: Postdoc Researcher / Team Leader
Lab: Computer Vision Lab (CVL)
Other team members: The VarCity Team: Prof. Luc Van Gool / Dr. Ralf Dragon / Dr. Junseok Kwon / Dr. Kenneth Vanhoey / Dr. Danda Pani Paudel / Andras Bodis-Szomoru / Dengxin Dai; Michael Gygli / Nikolay Kobyshev / Till Kroeger / Santiago Manen / Dr. Andelo Martinovic / Dr. Markus Mathias / Dr. Julien Weissenberg

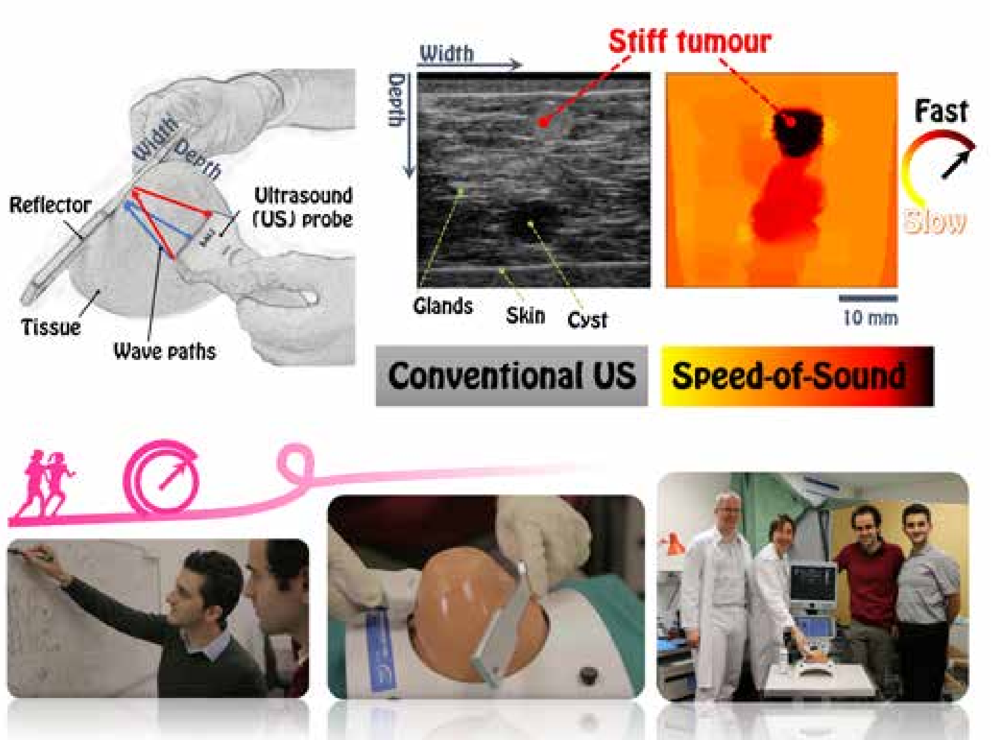
Autonomous sailing trimaran on the lake of Zurich

The photo shows the model trimaran sailing autonomously on the lake of Zurich. We equipped a commercially available radio-controlled trimaran with sensors to detect the wind and its position, actuators to steer and regulate the sails and an on-board processor that commands the actuators and enables the boat to sail autonomously.

The current research focuses on fusing information from unreliable sensors in order to obtain a stable and accurate wind measurement. This is of paramount importance as the algorithms for sailing autonomously heavily rely on an accurate estimate of the wind speed and direction. The goal of the Autonomous Sailing Project is to build a reliable platform for testing advanced control and navigation algorithms for autonomous vehicles.

Name: Simon Rüdt
Position: Master Student
Lab: Automatic Control Laboratory (IfA)
Other team member: Marcello Colombino, PhD Student (IfA)

D-ITET
RESEARCH PHOTO COMPETITION
2016

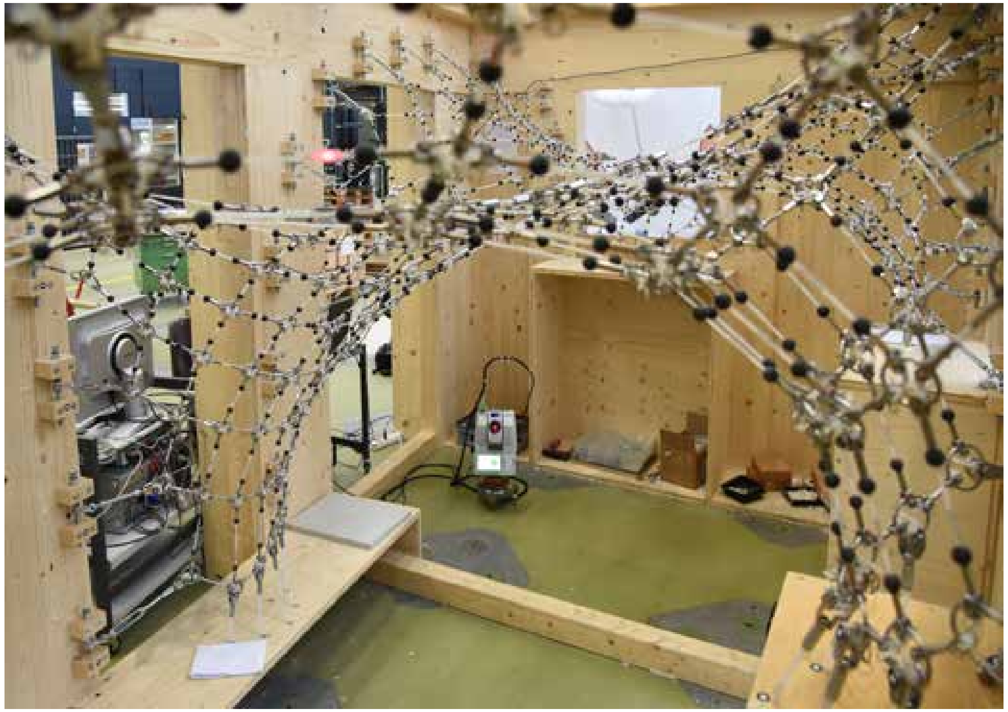


Hand-held ultrasound imaging of breast cancer: When speed matters most

The faster breast cancer is diagnosed, the higher is the chance for a cure. X-ray mammography is the current choice for breast screening, however, it requires radiation exposure and causes discomfort. Ultrasound is safe, however, conventional images based on tissue scattering are not sensitive to cancer. On the other hand, tumors are stiffer than the surrounding tissue, and, as a result, sound travels faster through them. Consequently, if we can measure the local speed-of-sound (SoS) we can infer if a point is a cancer or a normal tissue. We have developed a hand-held apparatus that uses a conventional ultrasound probe on one side of the tissue and a passive reflector on the other side. With this setup, we measure the travel time along multiple wave paths, and devise mathematical techniques to reconstruct SoS images, which successfully delineate stiff tissue locations. This low-cost technology can bring hand-held breast screening to individual doctors' offices. In the fight against breast cancer, speed is now not only a must, but also a convenience medical diagnosis tool.

Name: Sergio Sanabria
Position: Dr., Senior Assistant
Lab: Computer Vision Laboratory (CVL), Computed-Assisted Applications in Medicine (CAiM)
Other team member: Orçun Goeksel, Prof., Assistant Professor, (CAiM)

D-ITET RESEARCH PHOTO COMPETITION 2016

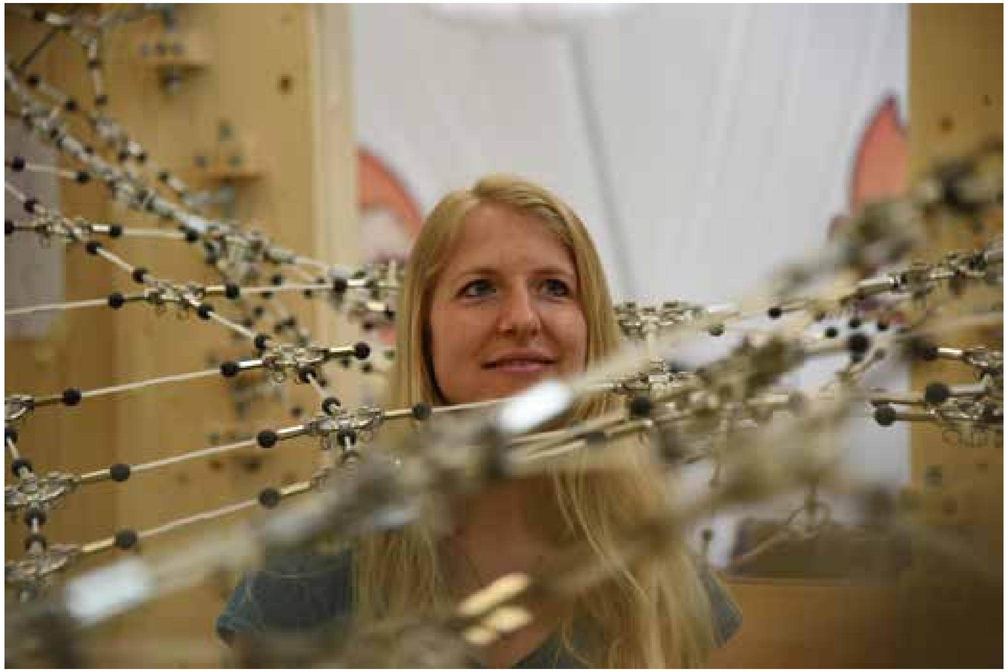


Controlling the form of an architectural cable net for light-weight construction

In architecture, doubly-curved thin concrete shells are very efficient light-weight structures, which save a lot of material and energy. Their construction is very difficult, as a complicated structure underneath is needed (formwork). An innovative simpler flexible formwork can be used, consisting of a rigid frame and a tensioned cable net – as in the picture. Fabric layers and the concrete go on top of it. Because of imprecisions in the construction, it is very hard to achieve the designed form of the shell, which is however crucial, as it is optimized for structural properties, such as stability. Therefore, we control the form of the cable net during its construction. With the theodolite in the picture, we measure the form of the net through the positions of the black markers. Our developed control algorithm tells us, which boundary edges we need to shorten or lengthen (via turnbuckles connecting the net to the frame), to bring the cable net closer to the designed form. Within the control algorithm, an optimization problem is solved many times. The developed control methods will be used in the construction of the so-called HiLo-Roof, a demonstrator roof on the NEST building at EMPA campus in Dübendorf. The picture shows a prototype (1:4) of the HiLo-Roof at Hönggerberg, ETH Zürich, (by the Block Research Group, our collaboration partners).

Name: Yvonne Stürz
Position: PhD Student
Lab: Automatic Control Laboratory (IfA)

D-ITET RESEARCH PHOTO COMPETITION 2016



Controlling the form of an architectural cable net for light-weight construction

In architecture, doubly-curved thin concrete shells are very efficient light-weight structures, which save a lot of material and energy. Their construction is very difficult, as a complicated structure underneath is needed (formwork). An innovative simpler flexible formwork can be used, consisting of a rigid frame and a tensioned cable net – as in the picture. Fabric layers and the concrete go on top of it. Because of imprecisions in the construction, it is very hard to achieve the designed form of the shell, which is however crucial, as it is optimized for structural properties, such as stability. Therefore, we control the form of the cable net during its construction. With the theodolite in the picture, we measure the form of the net through the positions of the black markers. Our developed control algorithm tells us, which boundary edges we need to shorten or lengthen (via turnbuckles connecting the net to the frame), to bring the cable net closer to the designed form. Within the control algorithm, an optimization problem is solved many times. The developed control methods will be used in the construction of the so-called HiLo-Roof, a demonstrator roof on the NEST building at EMPA campus in Dübendorf. The picture shows a prototype (1:4) of the HiLo-Roof at Hönggerberg, ETH Zürich, (by the Block Research Group, our collaboration partners).

Name: Yvonne Stürz
Position: PhD Student
Lab: Automatic Control Laboratory (IfA)

5th prize

D-ITET
RESEARCH
PHOTO
COMPETITION
2016

Enabling multiple robots to work together

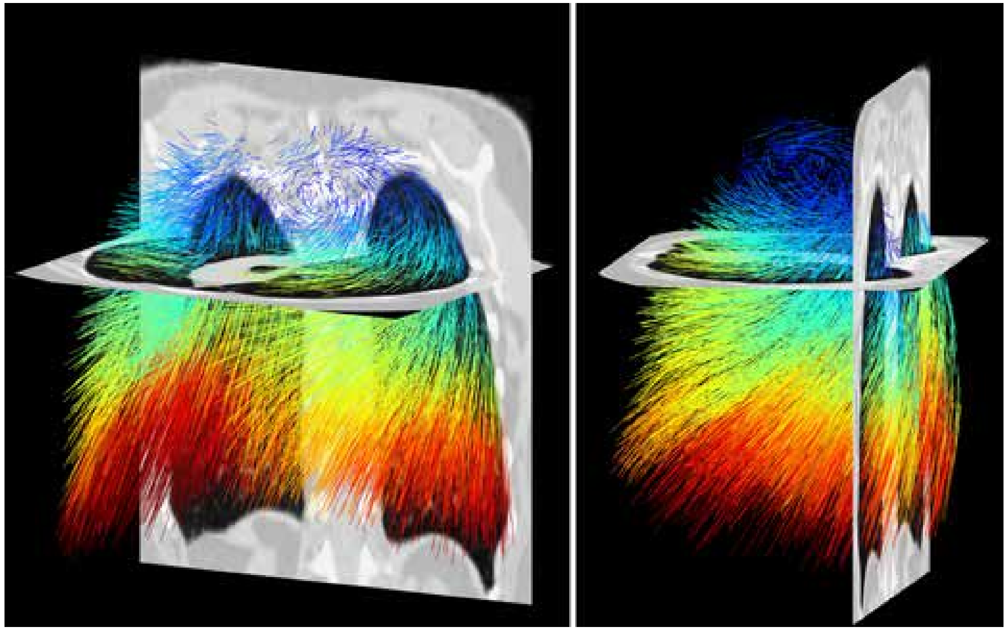
Robots increasingly enter industry as well as our everyday lives. Examples can be found in production lines, medical applications, or as service robots at our homes. And also on the construction site, it is planned to have robots tackle heavy tasks to help human workers.

There has been a lot of progress in the development and control of single robotic manipulators, however, the possibilities of multiple robots working together are still very limited.

Nevertheless, there are many complex tasks, which cannot be tackled by one robot alone, but only by a team of robots. Imagine for example a construction site where heavy or large objects need to be carried. In the photo, such a cooperative manipulation task is shown... for a bit lighter and smaller object. This task is very challenging as the actions of one robot influences the other one, which means that the robots really need to work together and interact and possibly also communicate with each other. Furthermore, both the position of the object as well as the interaction forces need to be controlled to make sure that the object is neither dropped nor squeezed and damaged. We therefore work on algorithms, which enable multiple robots to work together.

Name: Yvonne Stürz
Position: PhD Student
Lab: Automatic Control Laboratory (IfA)
Other team member: Annika Eichler, Postdoc, (IfA)

D-ITET RESEARCH PHOTO COMPETITION 2016



Visualization of human lung motion during breathing

The image visualizes the 3D motion inside human lungs. Motion magnitude is color-coded from blue (0 mm) to red (60 mm). The motion field was estimated by the developed automatic method from a pair of 3D X-ray computed tomography scans acquired during inhale and exhale breath-holds in 90 seconds. Such detailed and accurate breathing motion quantification can be used for thoracic radiotherapy to improve therapy planning and guidance, and for diagnosis of lung abnormalities.

Name: Valery Vishnevskiy
Position: PhD Student
Lab: Computer Vision Lab (CVL)
Other team members: Dr. Tobias Gass (CVL) / Dr. Christine Tanner (CVL) /
Prof. Dr. Orcun Goksel (CVL) / Prof. Dr. Gabor Szekely (CVL)

D-ITET RESEARCH PHOTO COMPETITION 2016

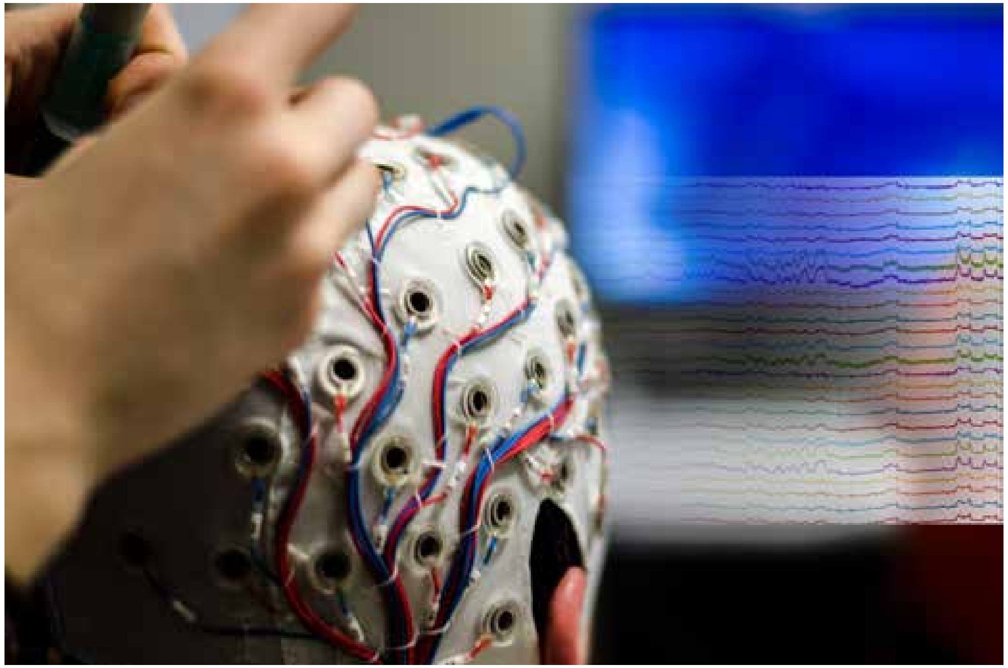
The balance between physical intuition and data driven control

The image shows a foil kite controlled by an autopilot. The photo was taken on the Dubendorf airfield during a tow test where an Airborne Wind Energy generator is towed by a truck to generate desired relative wind conditions. The kite is tethered to a motorised ground station on the vehicle and is controlled using real-time measurement. We apply system theory to model and control the kite behavior based on the obtained measurement data. The image illustrates the difficult balance between trusting the mathematical data and the intuition from operating the true physical system.

Airborne Wind Energy systems harvest wind energy by exploiting the aerodynamic forces generated by autonomous tethered wings, flying fast in crosswind conditions. This technology is able to reach higher altitudes than conventional wind turbines, where the wind is generally stronger and more consistent, while at the same time reducing the construction and installation costs of the generator.

Name: Tony Wood
Position: PhD Student
Lab: Automatic Control Laboratory (IfA)
Other team member: Eva Ahbe, PhD Student, (IfA)

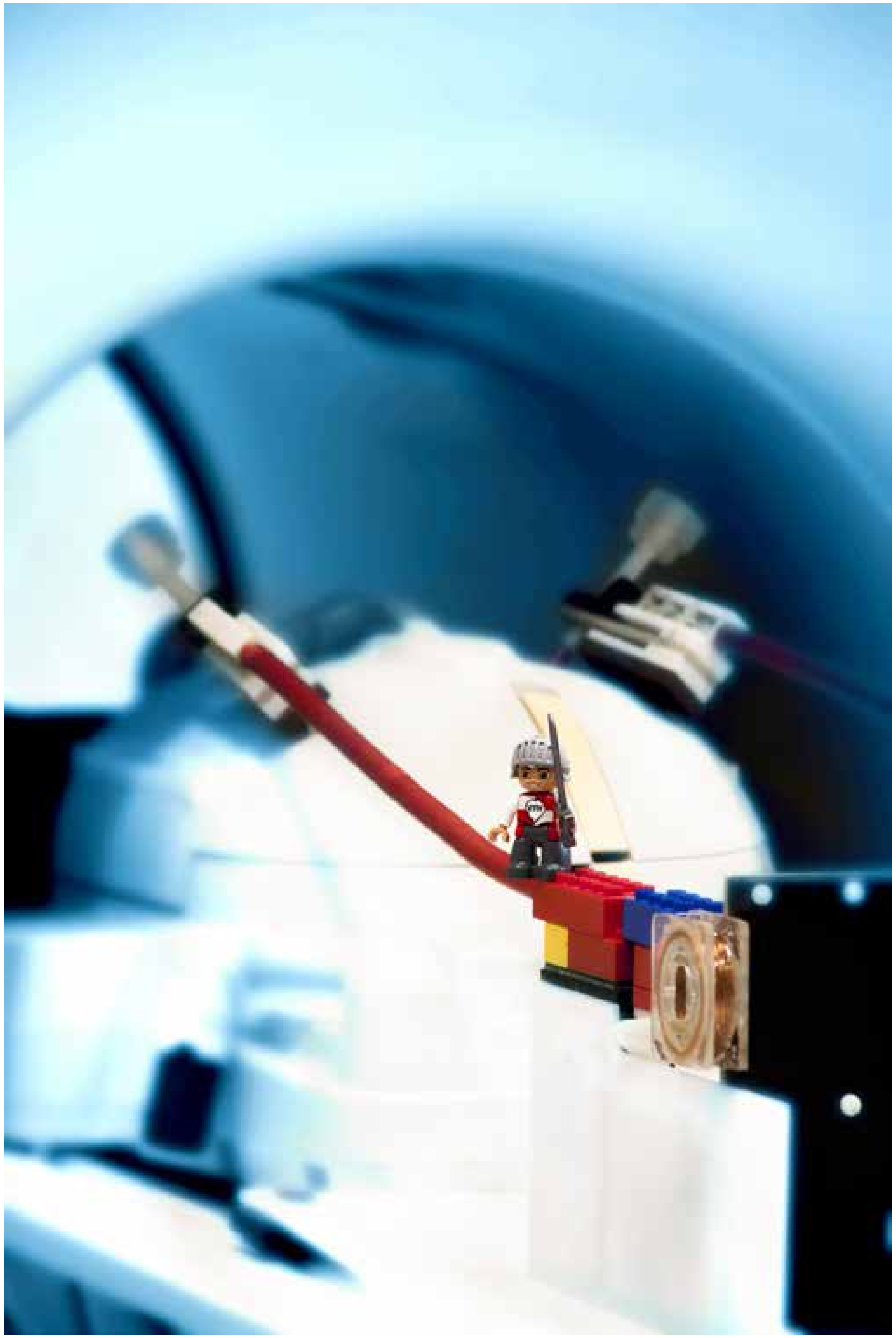
D-ITET
RESEARCH
PHOTO
COMPETITION
2016



Fingerprints of disease in brain waves

The project concerns about utilizing non-invasive techniques such as electro-encephalography (EEG) to understand psychiatric disorders. The image shows the preparation of an experiment where one scientist was currently checking on the impedances of the electrodes that needs to be kept low to ensure optimal signal to noise ratio. On the right side of the image is an example of the brain signals that have been recorded during experimental task in which the participant was instructed to focus on a centered box while being exposed to alternating tones. The main question here is: How can we make inference on the perception of the world by these recorded brain signals? The focus of our research is, on the one hand, to find methods or models that try to give an explanation on how diseases affect our cognition, and on the other hand, to find suitable therapies that aim to reverse the disease.

Name: Cao-Tri Do
Position: PhD Student
Lab: Translational Neuromodeling Unit (TNU)
Other team members: Frederike Petzschner, Post-Doc, (TNU) / Sara Tomiello, PhD Student, (TNU) / Gina Paolini, Research Assistant, (TNU) / Katharina Wellstein, Research Assistant, (TNU) / Lilian Elisabeth Weber, PhD Student, (TNU) / Saee Paliwal, PhD Student, (TNU)



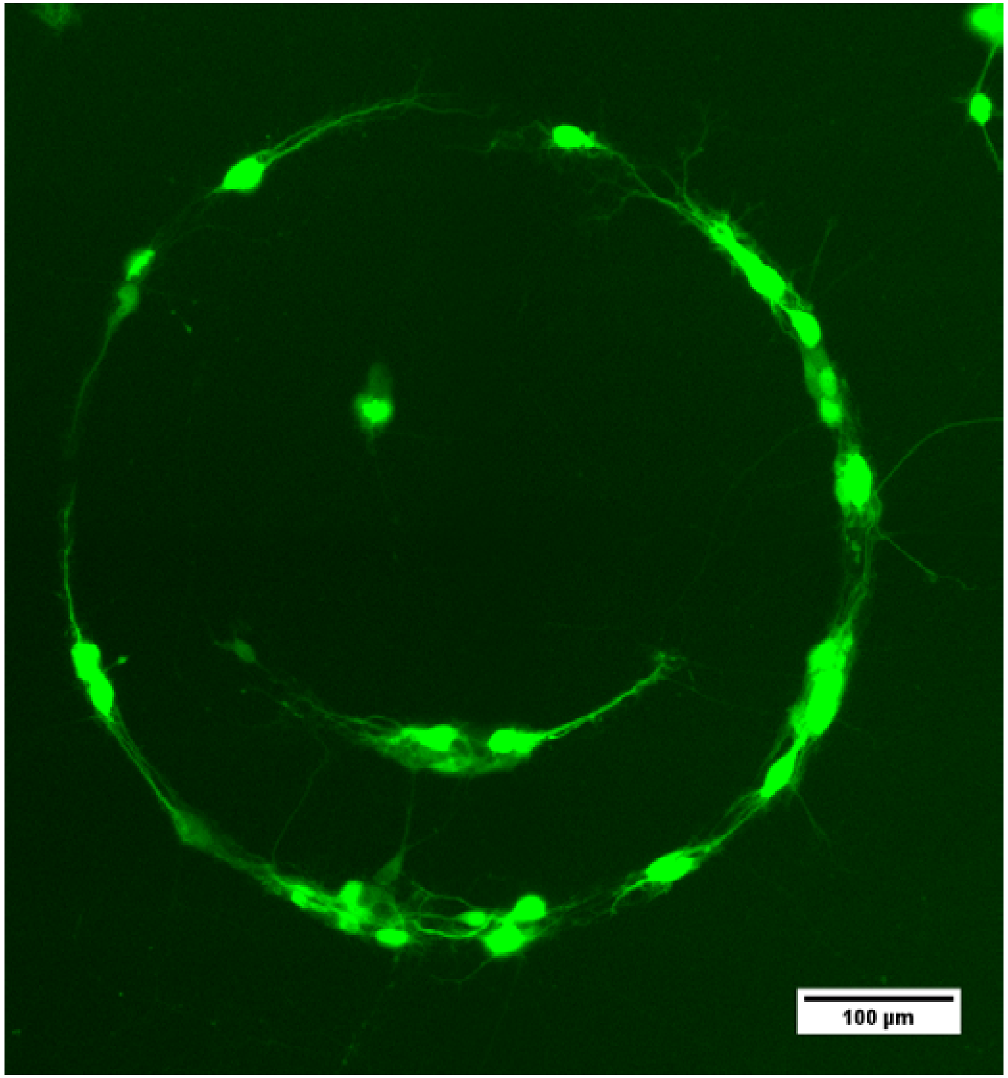
D-ITET
RESEARCH PHOTO COMPETITION
2016

Imaging the force of cancer

The picture portrays a Duplo soldier raising his sword ready to fight, while standing on top of our magnetic resonance elastography (MRE) setup. In the background, the MRI bore and a head coil can be seen, which is protruded by mechanical actuators used to induce shear waves in the human brain. The wave's force causes a tiny deformation of the brain tissue, which is measured using MRI, and ultimately converted into 3-dimensional stiffness maps. These can then be used to screen for cancer. This research contributes to the world wide challenge of fighting cancer by providing a new indicator for carcinogenic tissue, as well as, a foundation for new cancer treatment techniques.

Name: Christian Günthner
Position: PhD Student
Lab: Cardiovascular Magnetic Resonance Group, Prof. Sebastian Kozerke

D-ITET RESEARCH PHOTO COMPETITION 2016



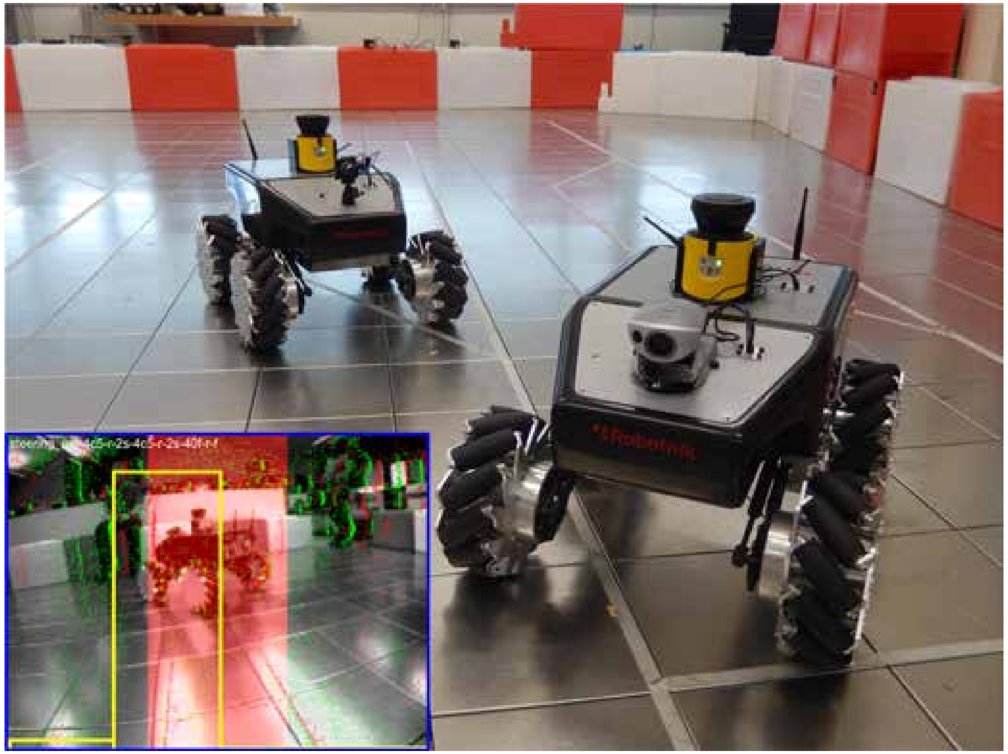
Artificial little brain in a smiley-like pattern

The image represents a network of primary hippocampal embryonic rat neurons arranged in a smiley-like orientation by combination of two methods: i) the substrate is initially chemically patterned by "printing" of adhesive (PDL) and repulsive (PLL-g-PEG) biomolecules and ii) neuron cells are locally patterned following the initial adhesive/repulsive pattern arrangement. On the picture, the neurons were transfected with an adeno-associated virus using a synapsin promoter, expressing a calcium indicator GCaMP6s fluorescing green (GFP). The image pictures the neuron activity 12 days after initial patterning. The whole procedure was performed using hollow photoplastic cantilevers made of SU-8 polymer.

The concept of "patterning of neurons with arbitrary defined topology" was initiated at LBB to better understand the basic mechanisms of neurology such as neuron development, signal transmission and neurocomputation. By this deterministic approach, we hope to better control and correlate the response of a neuron to an external signal. Since present approaches all consist of statistical measurements, our approach could lead to important discoveries.

Name: Vincent Martinez
Position: PhD Student
Lab: Laboratory of Biosensors and Bioelectronics (LBB)
Other team members: Csaba Forró, PhD Student, (LBB) / Serge Weydert, PhD Student, (LBB) / Mathias J. Aebersold, PhD Student, (LBB) / Harald Dermutz, PhD Student, (LBB) / Greta Thompson-Steckel, PhD Student, (LBB) / Orane Guillaume-Gentil, PhD Student, (LBB) / Tomaso Zambelli, PD Dr. or Assistant Professor, (LBB) / János Vörös, Professorl, (LBB) / László Demkó, Postdoc, (LBB)

D-ITET RESEARCH PHOTO COMPETITION 2016



Teaching a robot how to hunt

The project result portrayed in the image, is a perfect example of what is "Neuromorphic Engineering": understanding the underlying principles of the brain and implementing them into hardware in order to achieve fast and intelligent computations. Two 40 kg, omnidirectional and fast predator and prey robots are shown in an arena. The visual of what the predator robot sees through our special silicon retina sensor is also shown. This sensor mimics the processing of the human retina by reporting, at high speeds, only changes in luminosity and, therefore, movement. This drives an artificial neural network on the onboard PC. which extracts important features of the scene and understands where the other prey robot is. By giving steering directions to the predator, the network allows to track and follow at 3 m/s its prey. Even if a human guides the prey with a controller, it is nearly impossible to escape. The success of this work pushes researches to test what we know about the brain and leads to possible applications in self-driving vehicles and drones, and even toys (an interactive companions if the recognition is changed to another target).

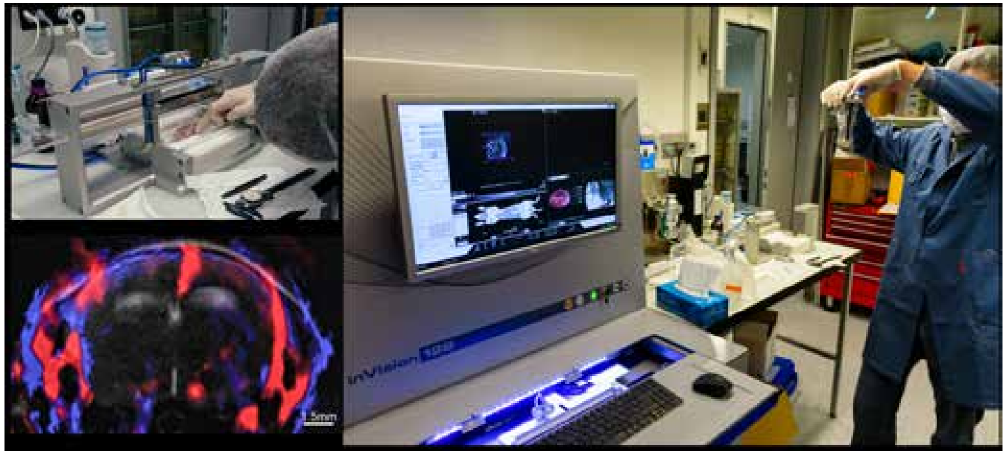
Name: Diederik Paul Moeys
Position: PhD Student
Lab: Sensors' Group at the Institute of Neuroinformatics

D-ITET RESEARCH PHOTO COMPETITION 2016

A heart for science

The image depicts the setup for an electroencephalography experiment in which we measure how the brain represents information about our heart. The picture shows two scientists inside the EEG cabin, who work on the EEG cap. The syringes contain a salty liquid to improve the impedances of the electrodes on the EEG cap to measure brain activity. The other two scientists outside the cabin test the quality of the heart signal (ECG). You can get a glimpse of the heartbeat signal in the lower window on the computer screen. During the experiment participants will see a beating heart – the one on the very right computer screen – which is adjusted to their true heartbeat. At some point during the experiment the computer heart will stop matching the true heartbeat. We measure when and how in the brain this mismatch between exteroceptive (visual and auditory) information and interoceptive (internal signals of the heartbeat) is computed. Using mathematical models we can then measure how much each individual uses the information that comes from the body and how noisy that information is.

Name: Dr. Frederike Petzschner
Position: Postdoc
Lab: Translational Neuromodeling Unit (TNU)
Other team members: Cao-Tri Do, PhD Student, (TNU) / Sara Tomiello, PhD Student, (TNU) / Gina Paolini, Research Assistant, (TNU) / Katharina Wellstein, Research Assistant, (TNU) / Lilian Elisabeth Weber, PhD Student, (TNU) / Saee Paliwal, PhD Student, (TNU)



Observing the mouse brain with lasers and ultrasound

The image shows multi-spectral optoacoustic tomography (MSOT). It uses the so called optoacoustic effect: Laser beams shined on the mouse excite various molecules which thereby emit ultrasound waves. Detectors receive those waves and reconstruct various information in 3D. This procedure is currently developed for clinical applications in humans. The mouse is a special hairless strain as the fur would disturb the ultrasound waves. It is wrapped in plastic film and receives oxygen and anesthesia through a mask (upper left). The detectors are built around a water bath, into which the mouse is completely immersed (right photo) to prevent tissue/air interfaces. On the lower left, the cross-section of a mouse brain is shown. Areas with oxygenated blood (red) and deoxygenated blood (blue) can be visualized owing to their different optoacoustic properties. Noninvasive procedures for in-vivo imaging have great potential to improve diagnosis in patients for diseases such as cancer and stroke.

Name: Felix Schlegel
Position: PhD Student
Lab: Institute for Biomedical Engineering (IBT), Prof. Markus Rudin
Other team member: Martin Schneider, PhD Student, (IBT)

D-ITET
RESEARCH
PHOTO
COMPETITION
2016

Brainstorm

The process of reconstructing virtual nerve fiber bundles is visualized from the acquisition in the magnetic resonance imaging scanner over the reconstruction of the local orientation distribution functions to the final tractogram. A tractogram maps the axonal connections in the brain white-matter between different cortical areas.

Diffusion MRI is sensitive to microstructural tissue properties and it can be used in white-matter research and clinical work to non-invasively explore brain anatomy and structure in vivo. It allows the mapping of the diffusion process of molecules, mainly water, in biological tissues. Besides the application in neurosurgical planning prior to removing brain tumors, tractography also proved to be a useful tool in clinical neuroscience, providing in vivo markers of disease severity or response to therapy and shedding light on processes of progression and recovery.

Name: Stefan Sommer
Position: PhD Student
Lab: Institute for Biomedical Engineering (IBT)

Using high speed MRI to visualize sugar consumption of the heart

Cardiovascular diseases are the number one cause of death worldwide. We are working on the next generation of non-invasive, MRI based tools to improve diagnosis and therapy guidance of the heart.

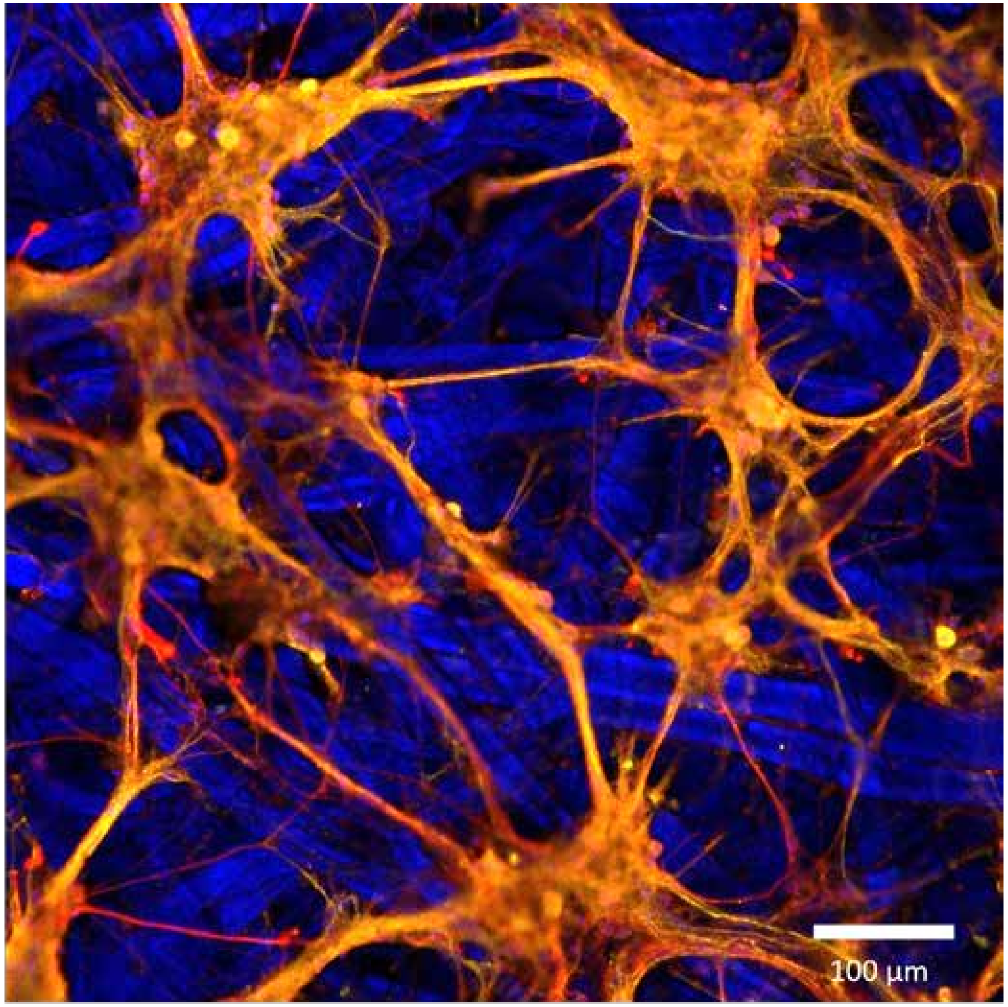
More precisely, we develop hyperpolarized MRI contrast agents to visualize how the heart uses energy in real-time. Using cutting-edge technology, we can “magne-tize” important metabolic molecules. By this the MR sensitivity increases by more than 35’000-fold, enabling the observation of smallest amounts of substance.

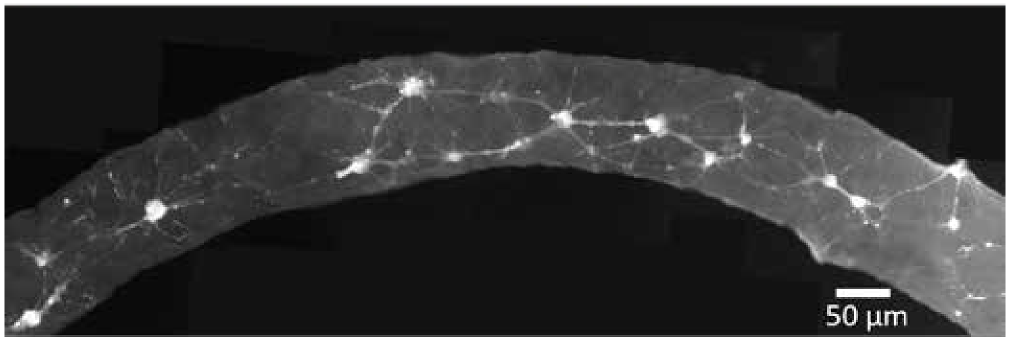
However, this sensitivity increase is short-lived and in order to minimize the time before injection, our fittest PhD Student sprints with the hyperpolarized contrast agent (yellow syringe) to the MRI scanner (background), where it is injected into an animal (and in the future into human patients).

Name: Jonas Steinhauser
Position: PhD Student
Lab: Prof. Sebastian Kozerke, Institute for Biomedical Engineering (IBT)
Other team members: Grzegorz Kwiatkowski, Post-Doctoral Fellow, Kozerke Group / Patrick Wespi, PhD Student, Kozerke Group

5th prize

D-ITET RESEARCH PHOTO COMPETITION 2016

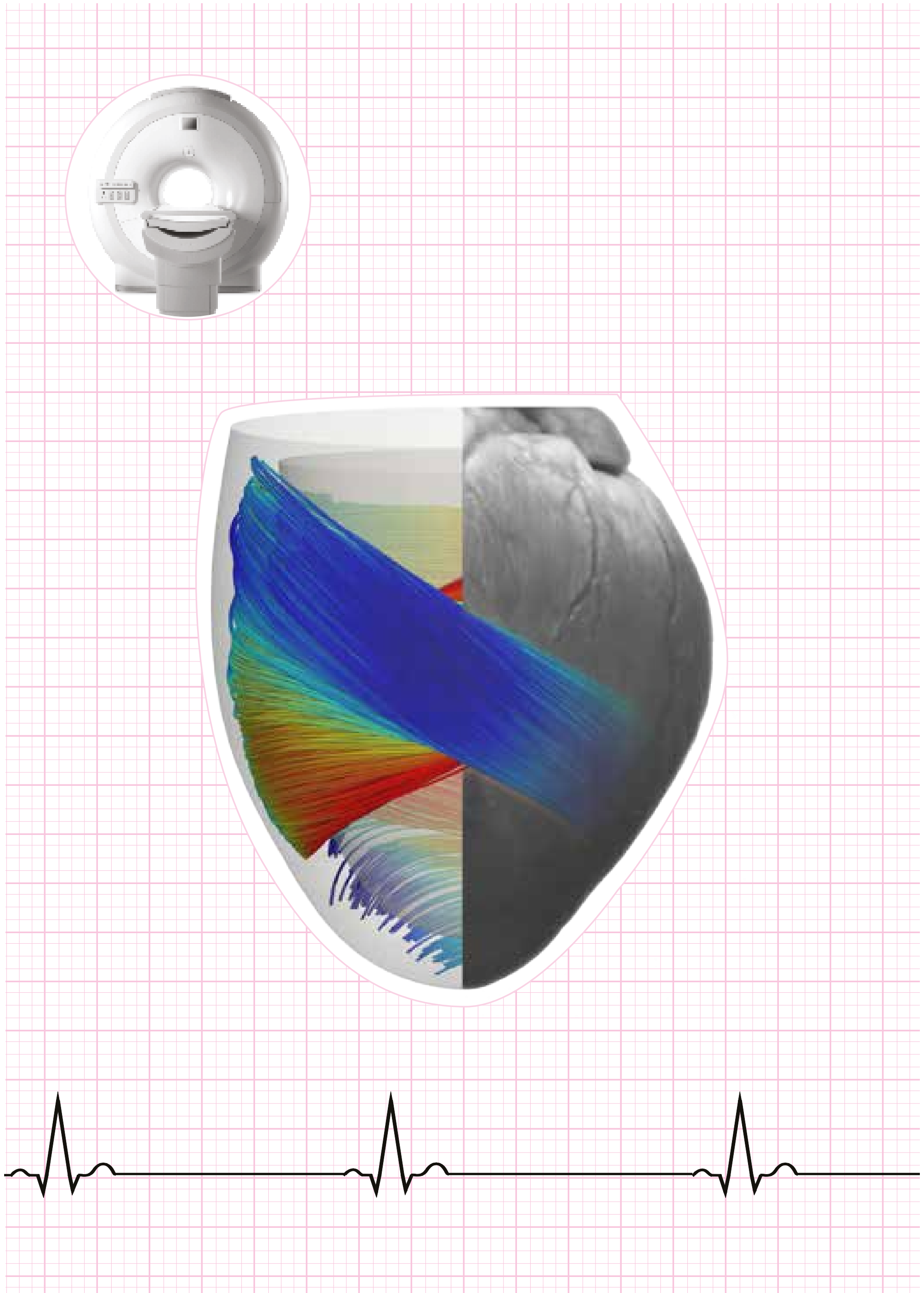




Cortical neural network within a 3D paper matrix

While connectomics has greatly advanced the knowledge of network mapping within the brain, well-defined activity patterns and characteristics of neural circuits remain difficult to characterize in vivo. Our aim is to scale down complex neural circuits to well-defined networks in vitro, where we can control exact electrical inputs and monitor the output, while minimizing the countless confounding factors present in vivo. Here, cortical neurons have formed a 3D network within a cellulose paper matrix [top image]. The dendrites (yellow) are the receiving structure of a neuron, while the axons (red) relay the output to the next neurons within the network. Neurons communicate via electrochemical signaling and are electrically active cells. Thus, by integrating a neural network with a multielectrode array (MEA), we are able to probe exact neural nodes with an electrical stimulus and then monitor and measure the electrical output that signifies neural activity. Using paper as a substrate allows us to build structured 3D networks that can easily be transferred to a MEA for high throughput analysis at multiple time points. Currently, the project is focused on creating looped neural circuits by using a ring geometry [bottom image] and measuring the correlation of electrical activity compared to random, unorganized networks.

Name: Greta Thompson-Steckel
Position: PhD Student
Lab: Laboratory of Biosensors and Bioelectronics, Janos Vörös
Other team member: Harald Dermutz, PhD Student, Laboratory of Biosensors and Bioelectronics

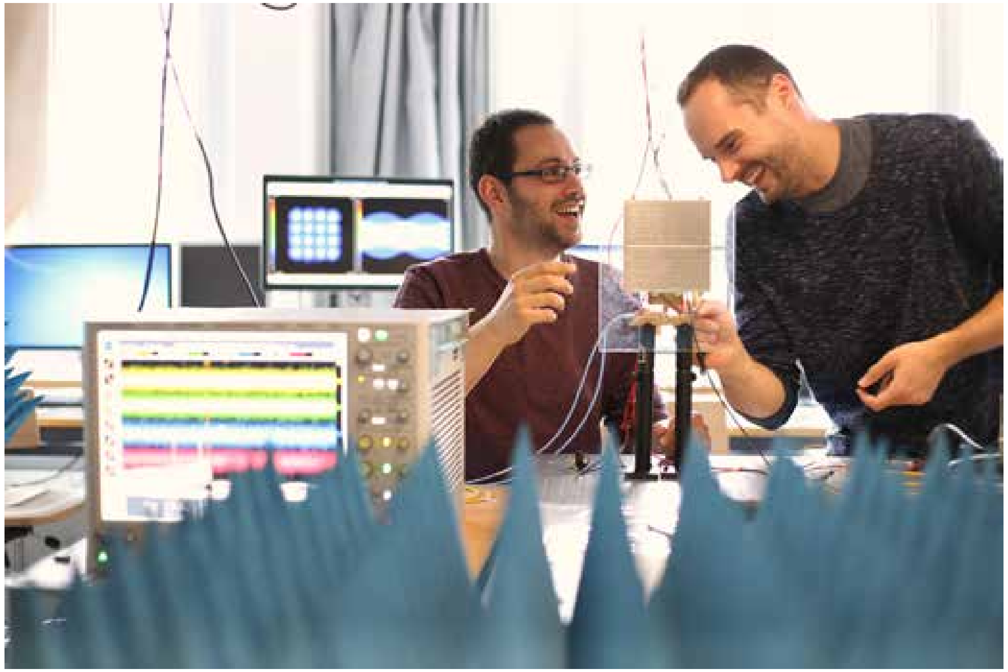


Human motor management

Our heart drives our everyday life. It follows a complex motion pattern to pump blood efficiently through our veins and arteries. It's made up of helical muscle fibres which have been examined in the past using optical imaging techniques. The old world of optics in medical imaging is represented in the right half of the image. New imaging techniques like Magnetic Resonance (MR) diffusion imaging can depict cardiac fibres from the outside of the human body while the subject is lying in an MR "scanner" as shown in the top left. Dedicated image reconstruction methods allow then to reconstruct the pathways of cardiac muscle fibres across the organ as colorfully depicted in the left picture. MR diffusion imaging allows to improve the current understanding of the living heart, e.g. how it is build up an how this relates to its function.

Name: Constantin von Deuster
Position: Scientific Staff
Lab: Institute for Biomedical Engineering (IBT)
Other team members: Christian Stoeck, Postdoc, (IBT) / Robbert van Gorkum, PhD Student, (IBT)

D-ITET
RESEARCH PHOTO COMPETITION
2016



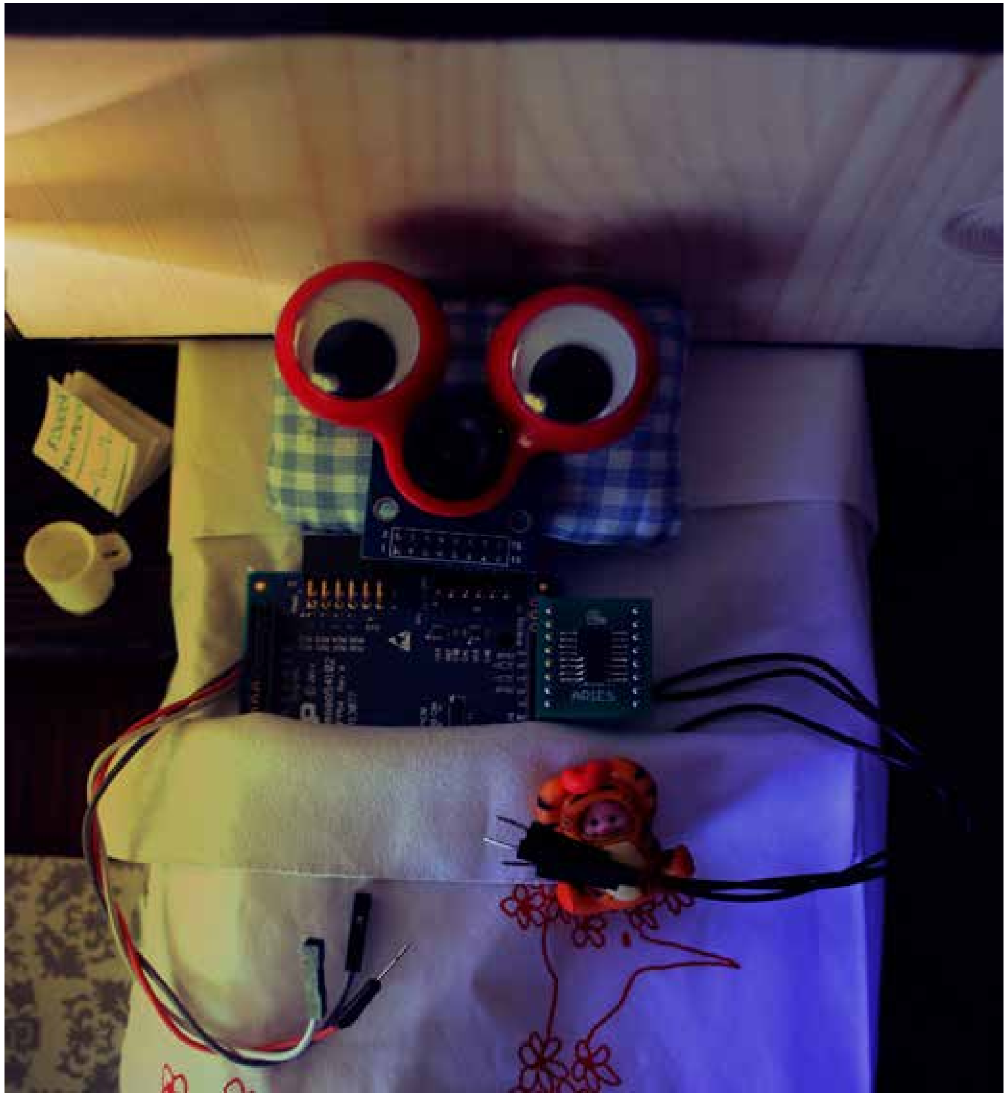
Research – A team effort

Research is a group effort. By working together we can benefit from a diversity of ideas and strengths creating a fun and productive working environment. Especially, in this rather competitive business, team work helps us to achieve things we never thought possible.

In the picture, Wolfgang and Felix are having a laugh while discussing possibilities and improvements of our high-speed wireless setup at 60 GHz. The receiving antenna unit, target of the discussion, can be seen in the middle while a hint of the decoded signal can be grasped on the display in the background. The next generation cellular network (5G) promises to deliver 1,000 times more data traffic than current networks, with unprecedented data rates for the users.

Such progress is needed to meet the ever-growing demand of bandwidth on mobile devices, e.g. tablets and smartphones. Radically novel approaches are needed to support multi-Gbit/s and even Tbit/s data rates needed for next generation networks. In our project, we work on novel control networks using optical technology. In this way, we can dramatically enhance the performance of wireless systems and antennas by using optical technologies. "Light-circuits" can be much faster and more broad-band than traditional electrical circuits. In this way, we can enable ultrafast speeds and the very large bandwidths to wireless communications systems needed in the near future.

Name: Felix Abrecht
Position: PhD Student
Lab: Institute of Electromagnetic Fields (IEF)
Other team members: Romain Bonjour, PhD Student, (IEF) / Maurizio Burla, Senior Researcher, (IEF) / Wolfgang Heni, PhD Student, (IEF) / Juerg Leuthold, Professor, (IEF)



Moritz the camera goes to sleep mode

Moritz, the camera (fitted with a pair of plastic eyes), gets ready to sleep. Moritz is no ordinary camera: he is a low-power transient camera. This means that most of the time you will find him sleeping because he needs to save his energy. He only wakes up when needed to capture photos, extract information from them, store them, and then ... he goes back to sleep.When Moritz sleeps, his electronics go into a low-power mode (sleep mode), where they consume no energy.

Moritz is special because he has 2 brains of different sizes! We say he is Heterogeneous. When he is awake, he uses each of them to do different tasks. Our research takes advantage of Moritz's double-brain to further reduce his energy consumption! This allows him to do impressive things like capturing pictures and processing them to give us information about what he sees, all without needing a battery nor charger!

Name: Andrawes Al Bahou
Position: Semester Thesis Student and Lab Assistant
Lab: Integrated Systems Laboratory (IIS)

4th prize

D-ITET RESEARCH PHOTO COMPETITION 2016

Steering towards 5G

The picture shows a 60 GHz phased antenna array in our laboratory. The signals from the four antennas interfere and create a strong beam in the desired direction i.e. towards the user. The direction of the beam can be steered by delaying the signals to the antennas with respect to each other. We design and realize circuits that are capable of changing the beam direction within one thousandth of a billionth of a second.

We believe, that in future mobile networks this extremely fast switching between users will enable almost simultaneous usage of resources for all users. Ultimately, this will tremendously increase the user data rates. After all, the next generation cellular network (5G) promises to deliver 1,000 times more data traffic than current networks – and we think ultra-fast beam steering is a way of achieving this.

Name: Romain Bonjour
Position: PhD Student
Lab: Institute of Electromagnetic Fields (IEF)
Other team members: Felix Abrecht, PhD Student, (IEF) / Maurizio Burla, Senior Researcher, (IEF) / Juerg Leuthold, Professor, (IEF)

D-ITET
RESEARCH PHOTO COMPETITION
2016

Getting on rats' nerves

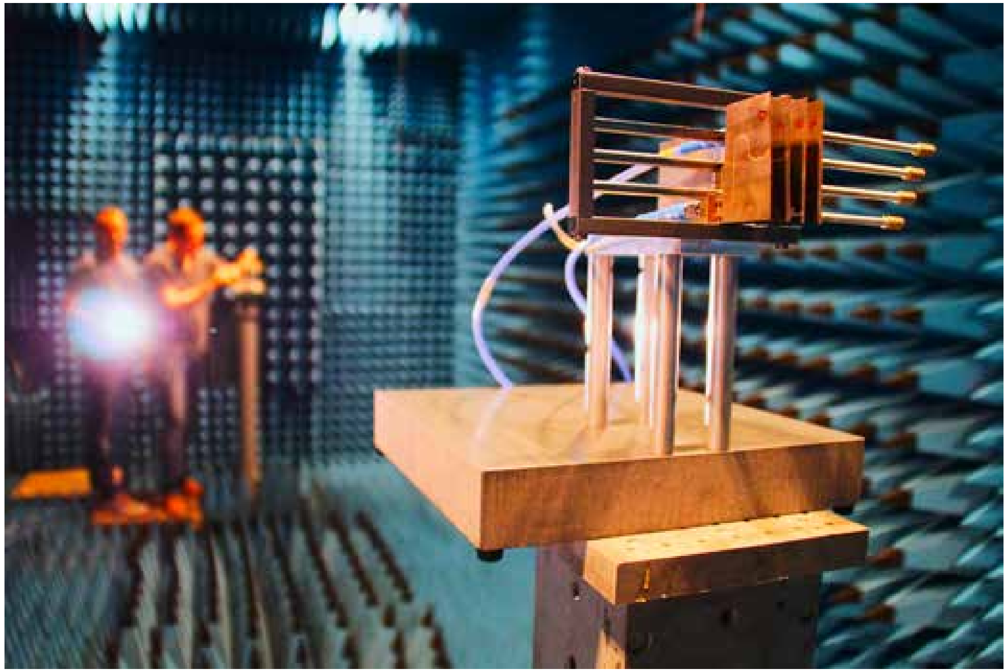
The photo depicts a rat holding a device developed at the integrated systems lab. The device enables recording of neural activity and stimulation of nerves as well as acquiring additional vital signs of rodents (e.g. blood pressure, heart rate, SpO2, temperature).

Researchers are interested in neural activity in order to better understand the physiology of living animals and humans and thus develop treatments. To obtain genuine results it is desired to take as little influence as possible during an experiment which ultimately means that the device must be implantable. In that way the subjects can walk around and live "normal lives" without being disturbed by cables, injuries, wounds, anaesthesia and the like.

This poses a plethora of challenges for example: size (shown device is 1x1x1cm3), power consumption (small battery), data transfer out of the device, controlling the device, bio-compatibility, reliability, usability etc. Many of these challenges are tackled by developing custom ASICs (micro chips).

Name: Noé Brun
Position: Technical Staff
Lab: Integrated Systems Lab (IIS)
Other team members: Philipp Schoenle, PhD Student, (IIS) / Thomas Kleier, Technical Staff, (IIS) / Thomas Burger, Research Associate / Pascale Meier, Technical Staff, (IIS) / Shekeb Fateh, PhD Student, (IIS) / Qiuting Huang, Professor, (IIS)

D-ITET
RESEARCH
PHOTO
COMPETITION
2016



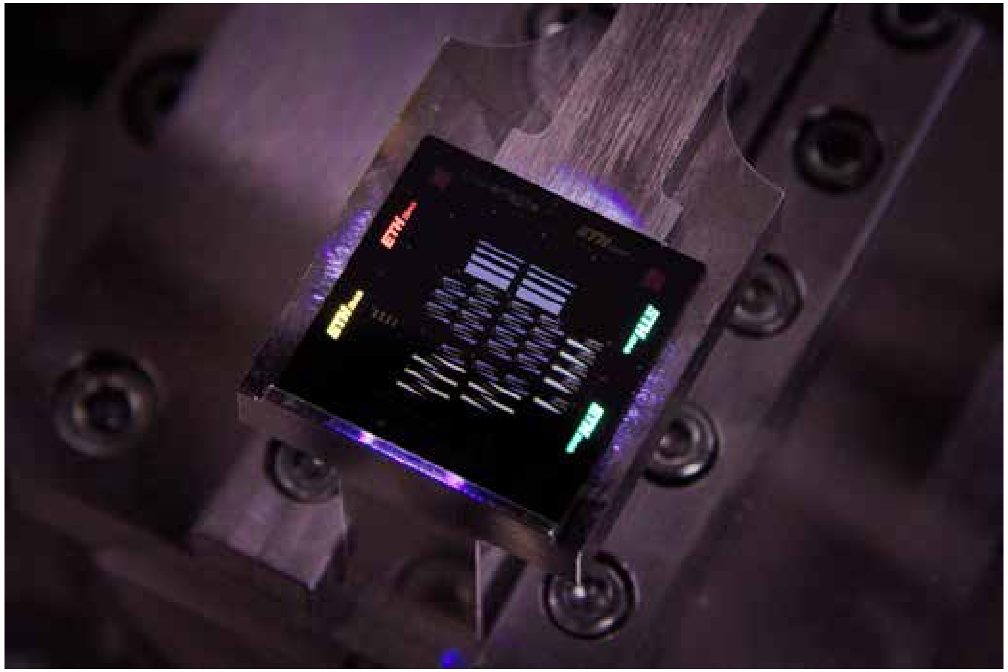
Radios and light: wireless systems for the future

Romain and Felix testing an ultra-wideband antenna array in the D-ITET anechoic chamber. The array of antennas in the foreground is designed to have ultra-broad bandwidth and the capability to change direction with ultra-fast speeds without any physical movement, but only via electrical control. The blue cones covering the walls, floor and ceiling of the chamber are designed to absorb the electromagnetic radiation, and simulate an ideal open space environment without any electrical disturbances.

The next generation cellular network (5G) promises to deliver 1,000 times more data traffic than current networks. Such progress is needed to meet the ever-growing demand of bandwidth on mobile devices, e.g. tablets and smartphones. Radically novel approaches are needed to support multi-Gbit/s and even Tbit/s data rates needed for next generation networks. In our project, we work on novel radio techniques using optical technology. In this way, we can dramatically enhance the performance of wireless systems and antennas. "Light-circuits" can be much faster and more broadband than traditional electrical circuits. This novel approach can enable ultrafast speeds and the very large bandwidths to wireless communications systems needed in the near future.

Name: Maurizio Burla
Position: Senior Researcher / Groupleader
Lab: Institute of Electromagnetic Fields (IEF)
Other team members: Romain Bonjour, PhD Student, (IEF) / Felix Christian Abrecht, PhD Student, (IEF) / Wolfgang Heni, PhD Student, (IEF) / Juerg Leuthold, Professor and Group Leader, (IEF)

1st prize



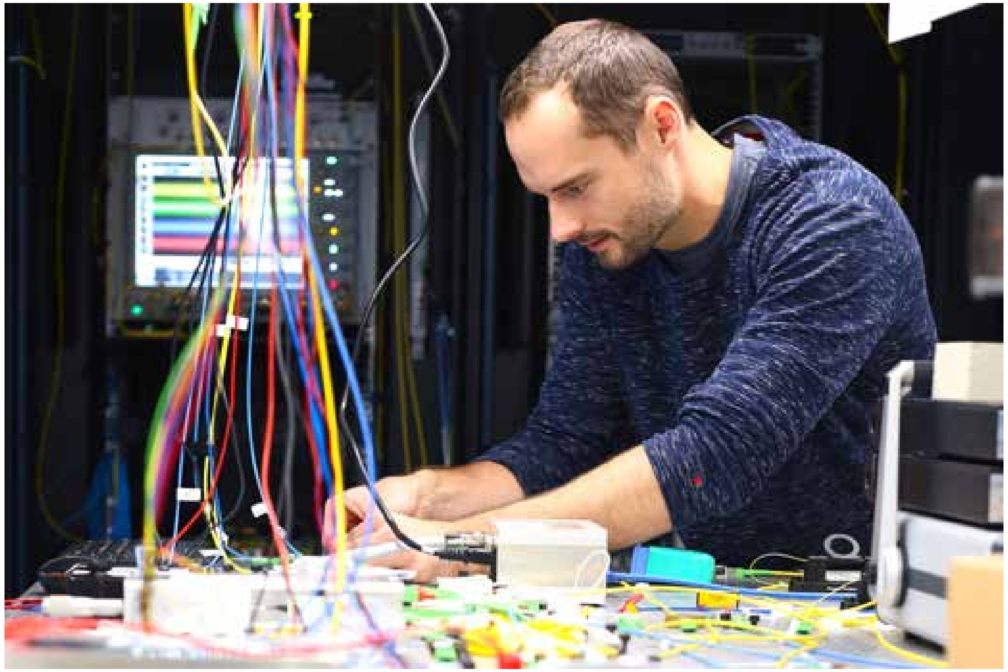
The colors of speed: ultrafast modulators

Photonic integrated circuit mounted on the test setup in our laboratory at the Institute of Electromagnetic Fields. The chip contains a novel type of modulators, called plasmonics organic hybrid modulators, that can encode information using light at ultrafast speeds (>110 GHz bandwidth), with ultra-compact footprints (10s μm2) and ultra-low power consumption (only 10s fJ/bit).

The next generation cellular network (5G) promises to deliver 1,000 times more data traffic than current networks, with unprecedented data rates for the users. Such progress is needed to meet the ever-growing demand of bandwidth on mobile devices, e.g. tablets and smartphones. Radically novel approaches are needed to support multi-Gbit/s and even Tbit/s data rates needed for next generation networks. In our project, we work on novel control networks using optical technology. In this way, we can dramatically enhance the performance of wireless systems and antennas by using optical technology. "Light-circuits" as the one in the picture can be much faster and broadband than traditional electrical circuits. In this way, we can enable ultrafast speeds and the very large bandwidths to wireless communications systems needed in the near future.

Name: Maurizio Burla
Position: Senior Researcher / Groupleader
Lab: Institute of Electromagnetic Fields (IEF)
Other team members: Wolfgang Heni, PhD Student; Felix Christian Abrecht, PhD Student, (IEF) / Romain Bonjour, PhD Student, (IEF) / Juerg Leuthold, Professor and Group Leader, (IEF)

D-ITET
RESEARCH
PHOTO
COMPETITION
2016

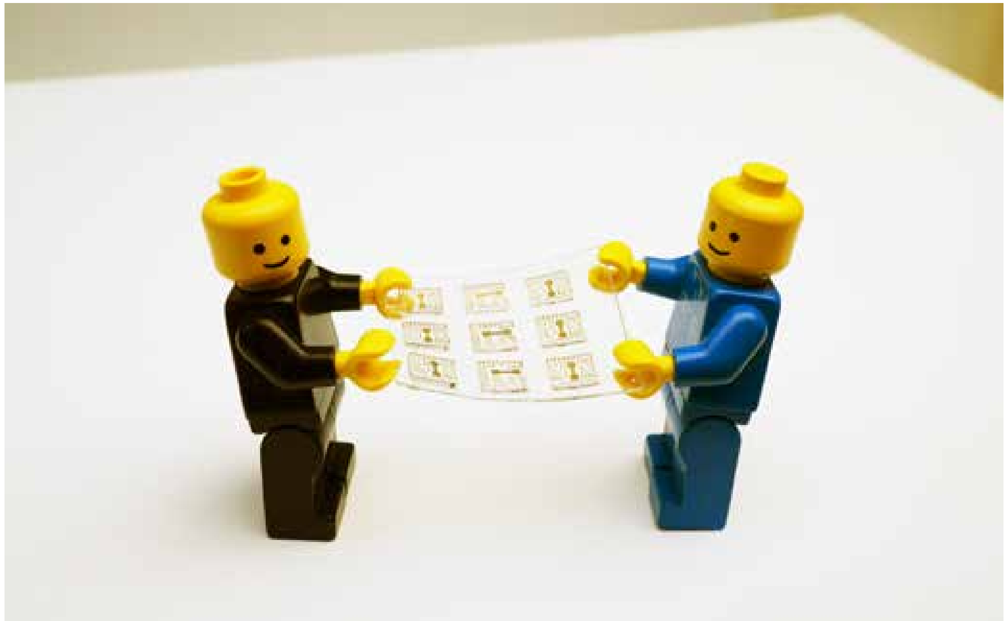


The wires for light

Felix Abrecht assembling a test setup in the Systems Laboratory of the IEF group, for an experiment on high-capacity wireless communication networks. The next generation cellular network (5G) promises to deliver 1,000 times more data traffic than current networks. Such progress is needed to meet the ever-growing demand of bandwidth on mobile devices, e.g. tablets and smartphones. Radically novel approaches are needed to support multi-Gbit/s and even Tbit/s data rates needed for next generation networks. In our project, we work on novel radio techniques using optical technology. In this way, we can dramatically enhance the performance of wireless systems and antennas. “Light-circuits” can be much faster and more broadband than traditional electrical circuits. This novel approach can enable ultrafast speeds and the very large bandwidths to wireless communications systems needed in the near future.

Name: Maurizio Burla
Position: Senior Researcher / Groupleader
Lab: Institute of Electromagnetic Fields (IEF)
Other team members: Felix Christian Abrecht, PhD Student; Romain Bonjour, PhD Student, (IEF) / Wolfgang Heni, PhD Student; Juerg Leuthold, Professor and Group Leader, (IEF)

D-ITET
RESEARCH
PHOTO
COMPETITION
2016



Stretchable electronics for daily life

How difficult would it be to “transform” every electronic device we commonly use in our daily life in a soft and lightweight item? In the last years, flexible electronics has gained great attention in the scientific scenario for new and futuristic applications. Integrating electronics in our clothes or monitoring human vital signs using such devices in our body are few examples of the potentiality of this field. In this picture, we show an approach to make simple electronic components (resistors) more flexible. Taking inspiration from the profile of a modern city, full of towers and skyscrapers, we “placed” these devices on flexible and tall pillars. Moreover, the transparent material used in the picture as substrate is also biocompatible, making it suitable for daily actions… like playing with toys!

Name: Giuseppe Cantarella
Position: PhD Student
Lab: Wearable Computing Lab
Other team members: Alberto Ferrero, Master Student, Wearable Computing Lab / Christian Vogt, PhD Student, Wearable Computing Lab

D-ITET RESEARCH PHOTO COMPETITION 2016

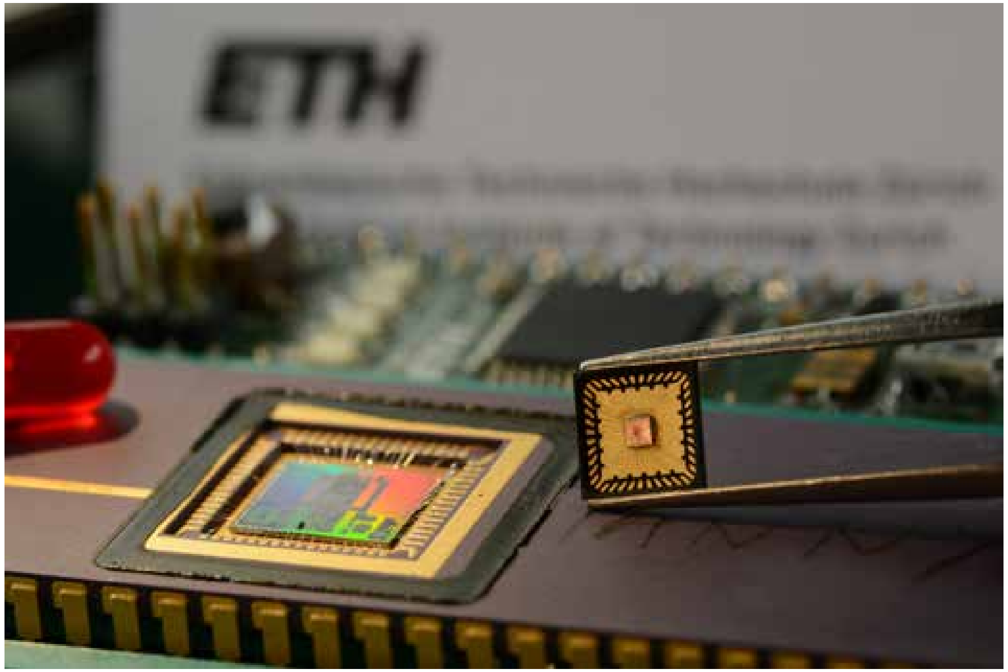
Inspired by nature; structural colors based on aluminum plasmonics

The photo shows a color filtering substrate in front of a Morpho butterfly. The substrate consists of four different patches and animals, showing structural colors in nature. In comparison to dyes, these colors are existent due to their nano-/ micrometer geometry interacting with the incident light. Addition of metals can also lead to such structural color effects, via collective oscillation of electrons, the so-called field of plasmonics. Here, the substrate consists of tilted aluminum nanolamellas with dimension of about 100nm. The asymmetric shape enables color appearance only in one direction and upon certain angles. Hereby the length of the nanolamellas defines the color tone as visible in the photo. This novel effect is based on the strong coupling between a localized and propagating resonance leading to Fano-like resonances. The strength of the resonance is so pronounced that the effect is clearly visible in diffuse daylight. Such substrates are highly attractive for optical security applications, but also for sensing and solar applications.

Name: Luc Duempelmann
Position: PhD Student
Lab: Photonics Laboratory, Prof. Lukas Novotny in collaboration with CSEM
Other team members: Benjamin Gallinet, senior R&D engineer, (CSEM) /
Daniele Casari, Master Student, (EPFL) / Angelique Luu-Dinh, R&D engineer /
Marc Schnieper, Section Head / Lukas Novotny, Professor

3rd prize

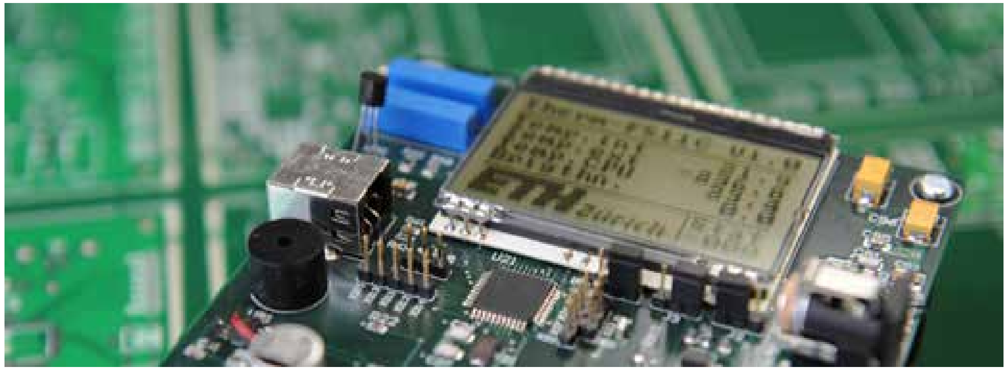
D-ITET
RESEARCH PHOTO COMPETITION
2016



Big and small

There are two microchips designed by IIS in this picture. The big one is called Manny, named after the Mammoth in the popular Ice Age franchise, and is one of the largest microchips designed at IIS measuring roughly 8mm by 7mm. If you look closely on the bottom right corner of the chip you can just about see a picture of Manny. This chip was manufactured by EM-Marin in Switzerland using a relatively mature 180nm technology and packaged in an old fashioned DIP64 package. The small chip being held by a pair of tweezers is Diana. It was manufactured with a more modern 65nm technology in Taiwan and measures only 1.25mm by 1.25mm and is in a very small QFN40 package. Interestingly, both microchips contain more or less the same, a four-core PULP system aimed at extremely energy efficient computing for low-power embedded applications. These two extremes allow us to experimentally verify the validity of our architectural choices over a wide range.

Name: Frank K. Gürkaynak
Position: Scientific Staff
Lab: Integrated Systems Laboratory (IIS)
Other team members: Digital Circuits and Systems Group, Prof. Benini, IIS /
Photograph made with help of Beat Muheim of Microelectronic Design Center

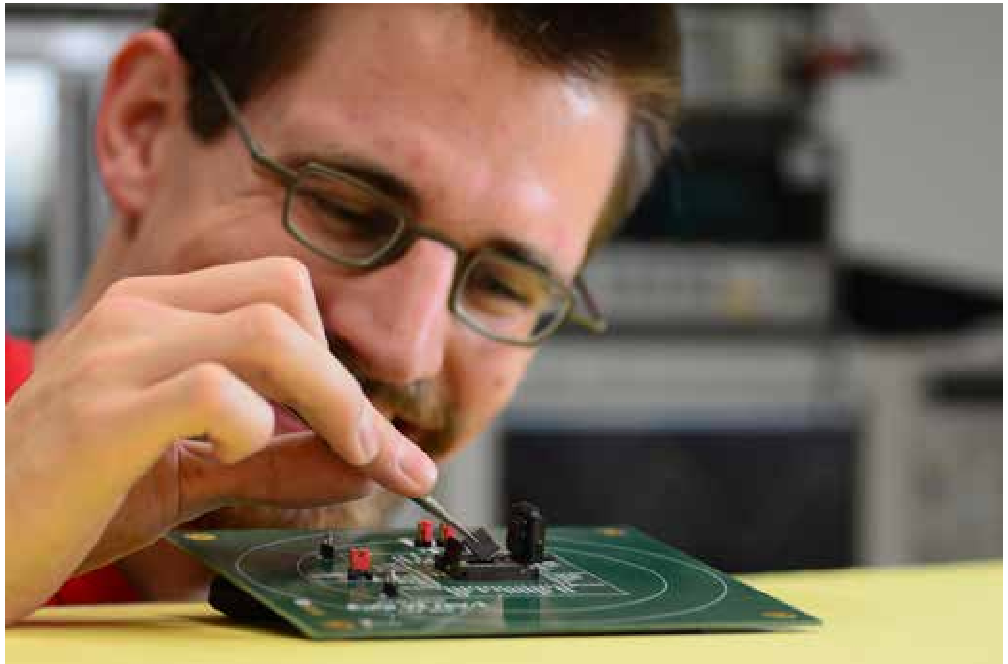


Taking your temperature @ETH Zurich

The Microelectronics Design Center organizes a Printed Circuit Board (PCB) design course every semester. Up to 24 students get hands on experience on actually designing their own PCB, which they later also assemble and see how it works.
We provide the students an example project, a small computing/sensing system with temperature and ambient light sensors, but students are also able to design their own projects during the course. Pictured is a finished student project in operation.

Name: Frank K. Gürkaynak
Position: Scientific Staff
Lab: Microelectronics Design Center
Other team members: Alfonso Blanco Fontao / Beat Muheim Bachl / Hubert Kaeslin / Staff Microelectronics Design Center

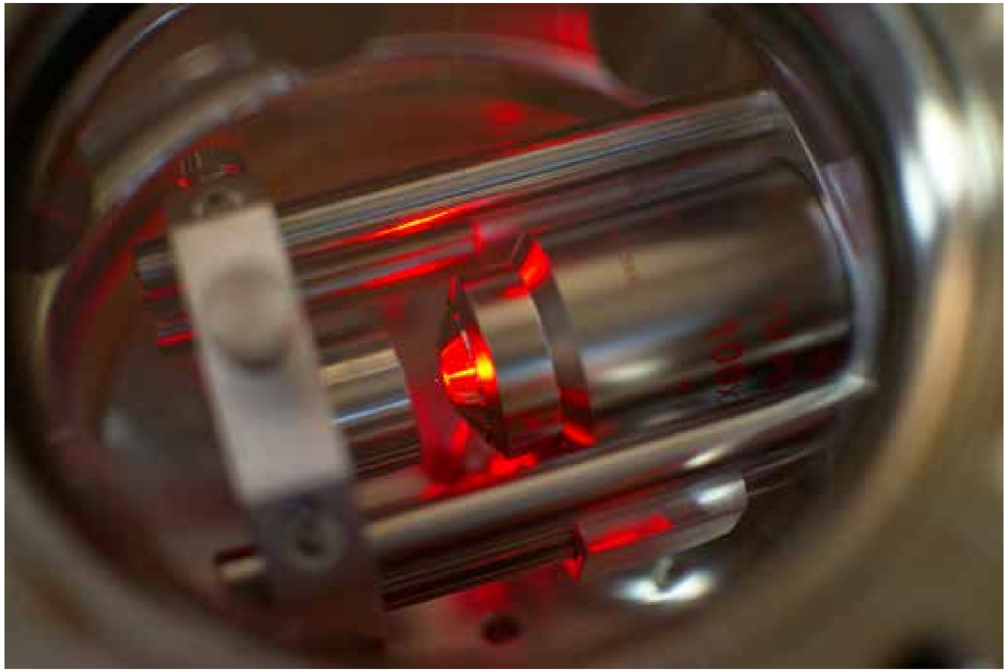
D-ITET
RESEARCH
PHOTO
COMPETITION
2016



Phisch and chips

Philipp Schoenle, a colleague from the IIS, is posing in this picture with a microchip that contains a first generation PULP system. Philipp uses PhiSch (which is pronounced like 'fish'), hence the word play on the title. The Microchip has been designed with (at the time) very advanced 28nm FDSOI technology provided by ST Microelectronics and was the most advanced manufacturing technology that was used to design a microchip with at ETH Zürich. The PULP project aims to achieve the highest energy efficiency possible for a processor system and is being developed to allow future Internet of Things (IoT) systems sufficient computing power to do complex computing tasks such as classification. In the mean time we have developed more than 15 microchips containing PULP technology including four in 28nm technology.

Name: Frank K. Gürkaynak
Position: Scientific Staff
Lab: Integrated Systems Laboratory (IIS)
Other team members: Digital circuits and Systems group, Prof. Benini (IIS) /
in the picture Philip Schoenle (PhiSch) from Analog group of IIS



Trapped by light

A look into the vacuum chamber shows an objective on the right that focuses a laser beam of 100mW power. In the center of the focus we trap a silica nano particle of 100nm radius. Optical gradient forces form a harmonic potential for the particle, such that it oscillates driven by collisions with the surrounding gas molecules. We detect the motion of the particle by looking at the scattered light that we collect with the lens on the left of the picture. This information we use to apply a feedback to the particle and reduce its motional amplitude to less than the size of a single atom. We perform our experiments in vacuum to decouple the particle from the environment. The goal is to reach the ground state of the motional energy, which will allow us to prepare the particle in a quantum state and help to answer unsolved questions in quantum physics.

Name: Erik Hebestreit
Position: PhD Student
Lab: Photonics Laboratory
Other team member: Vijay Jain, PhD Student, Photonics Lab

D-ITET RESEARCH PHOTO COMPETITION 2016

Fragile crystal heart

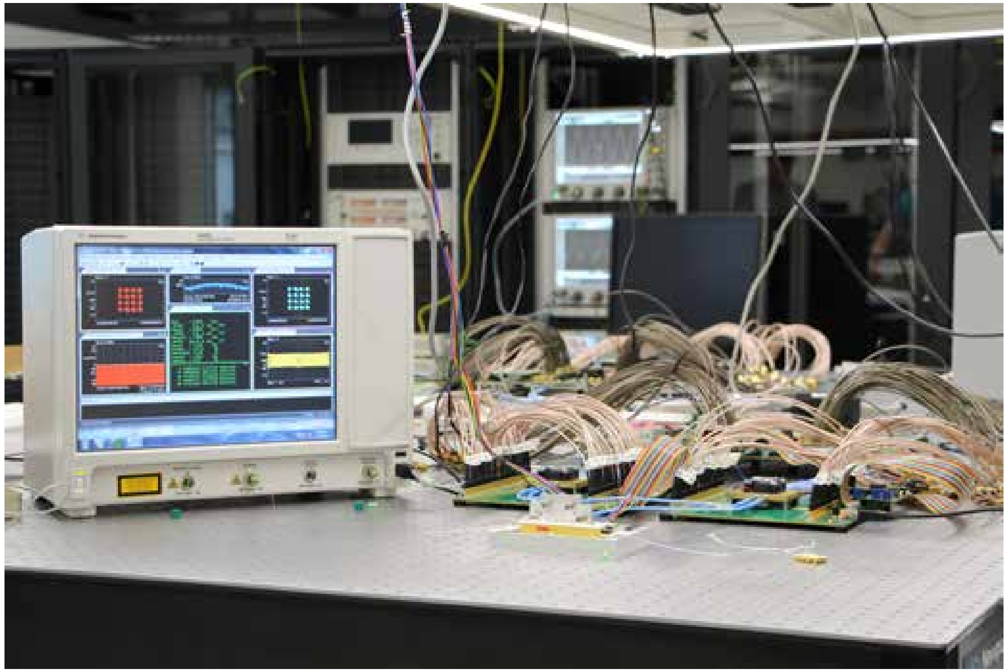
Part of our research is to do sophisticated measurements with laser optics to discover new physics. But another part is to scan through large substrates, sitting in front of the microscope for hours, hoping for the perfect "flake" to appear: It should be a thin, very flat crystal that we can then use as a cushion for other, more delicate crystal flakes.

At times, this process can be tedious. But when we saw this specific flake, it made our day! This delicate Boron-Nitride crystal heart is 25 micrometer long, that's less than the thickness of a hair. It gracefully lies on the Silicon substrate, waiting for someone to discover it.

The scientific samples we produce using flakes of such crystals help us understand the physics of single atomic layer materials. One day, devices made out of such crystals may be in our cellphone cameras, displays, or processors. But for now, it's just basic research: Discovering what's laid out there.

Name: Achint Jain
Position: PhD Student
Lab: Photonics Laboratory (Group leader: Prof. Lukas Novotny)
Other team member: Alexander Popert, PhD Student at Imamoglu Laboratory

D-ITET RESEARCH PHOTO COMPETITION 2016

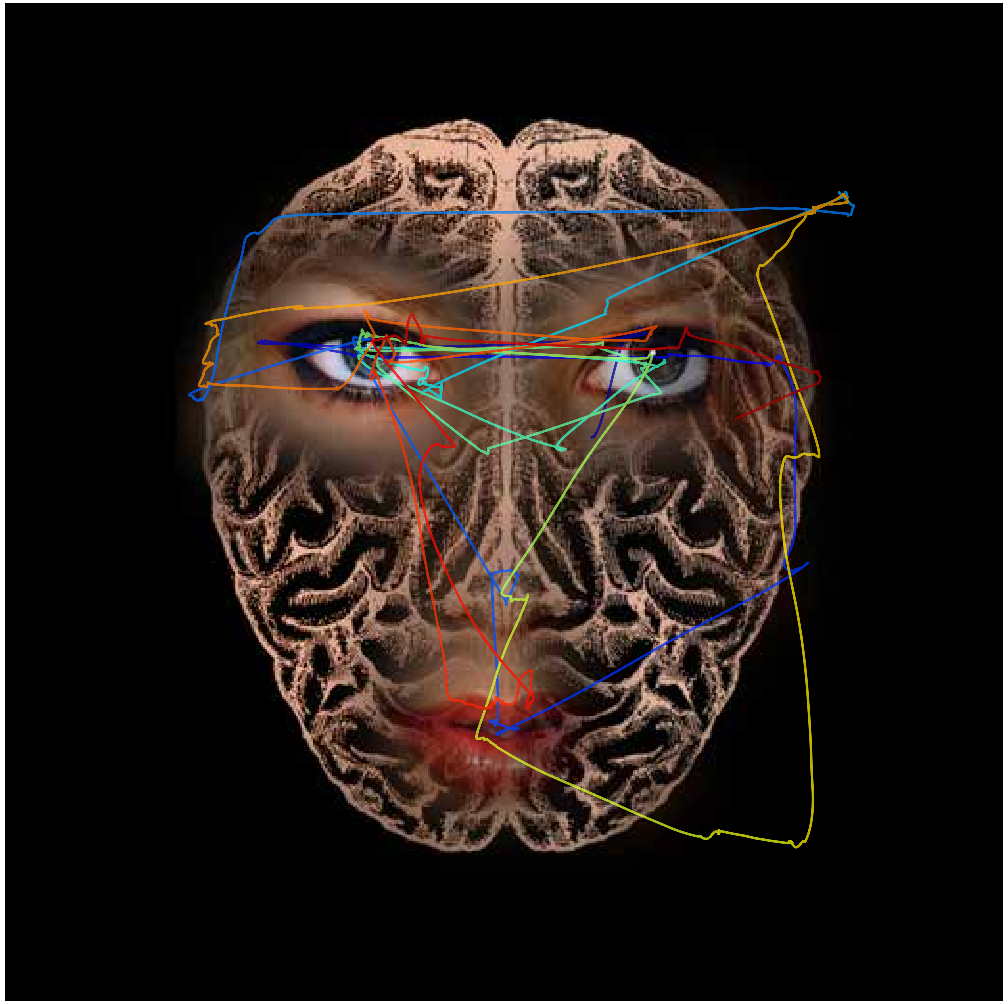


Optical communication – the future of high speed information transmission

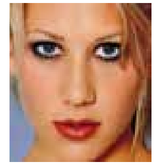
A real-time optical coherent transmitter is shown. Data is generated in computer chip. It is linked with the brownish electrical cables to two high speed analog-to-digital converters. This signal is used to modulate a laser light with highest speed. The blue cables are connecting the converters with an optical modulator (golden cuboid in the front). The oscilloscope on the left shows the performance analysis of the transmitter. Laser light is guided through the thin optical fibers (leaving and entering the green plugs at the bottom of the oscilloscope). This setup shows how the next step of high speed communication could be realized. Optical fibers are able to transmit much more information than an electrical cable (e.g. the USB connection everyone uses).

Name: Arne Josten
Position: PhD Student
Lab: Institute of Electromagnetic Fields (IEF)

D-ITET
RESEARCH
PHOTO
COMPETITION
2016



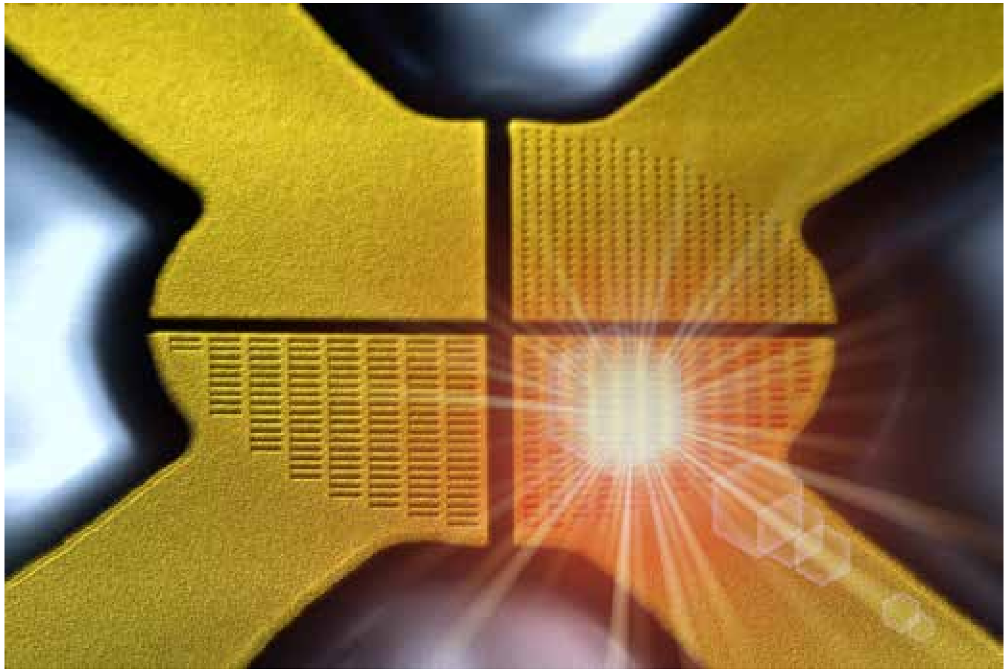
Seeing (?) Anna



During every wake second we move our eyes between 3 to 5 times towards interesting details of the environment. However, the gathered images are far from perfect. The resolution of our vision falls off quickly from the center of gaze (try reading the next but one line while fixating the following dot). Still, our brain creates a sharp and continuous percept of the world. The presented picture shows the eye movements (lines; colored by occurrence during the measurement: blue early, red late) while looking at Anna Kournikova (original picture to the right). Only the parts of the image which are actually sharp are shown – the rest is filled-in by our brain. This perception and eye movement control in general involves a vast neuronal network. The study of "oculomotor behavior" therefore provides a deep inside into the functioning of the brain. In our project at the IIS, we are building a mobile eye tracker to analyze eye movements during unconstrained behavior to provide an objective measure of the ability to drive in the elderly.

Name: David J. Mack
Position: Postdoc
Lab: U. Schwarz, Department of Neurology, USZ / Q. Huang, Integrated Systems Laboratory (IIS)

D-ITET RESEARCH PHOTO COMPETITION 2016



Light from optical antennas driven by quantum tunneling

Artistically rendered scanning electron microscope image (15000 x magnification) of slot antennas in a gold electrode. The antennas are 50nm wide and vary in length. A change in geometry tunes the resonance of the antenna, which generally lies at frequencies of several 100THz, corresponding to the visible part of the electromagnetic spectrum. Such antennas serve as optically active elements in integrated tunnel junctions where electrons tunnel inelastically, exciting the antenna which results in light emission. A single, electrically driven optical antenna – being smaller than the wavelength of light itself – is the smallest source of light demonstrated to date. Our research investigates the fundamental physics governing the light emission from such devices as well as the prospect of using optical antennas as future on-chip elements, serving as ultrafast interconnects between the electronic and the optical domain.

Reference: Nature Nanotechnology 10, 1058 (2015)

Name: Markus Parzefall
Position: PhD Student
Lab: Photonics Laboratory, Prof. Lukas Novotny

D-ITET RESEARCH PHOTO COMPETITION 2016

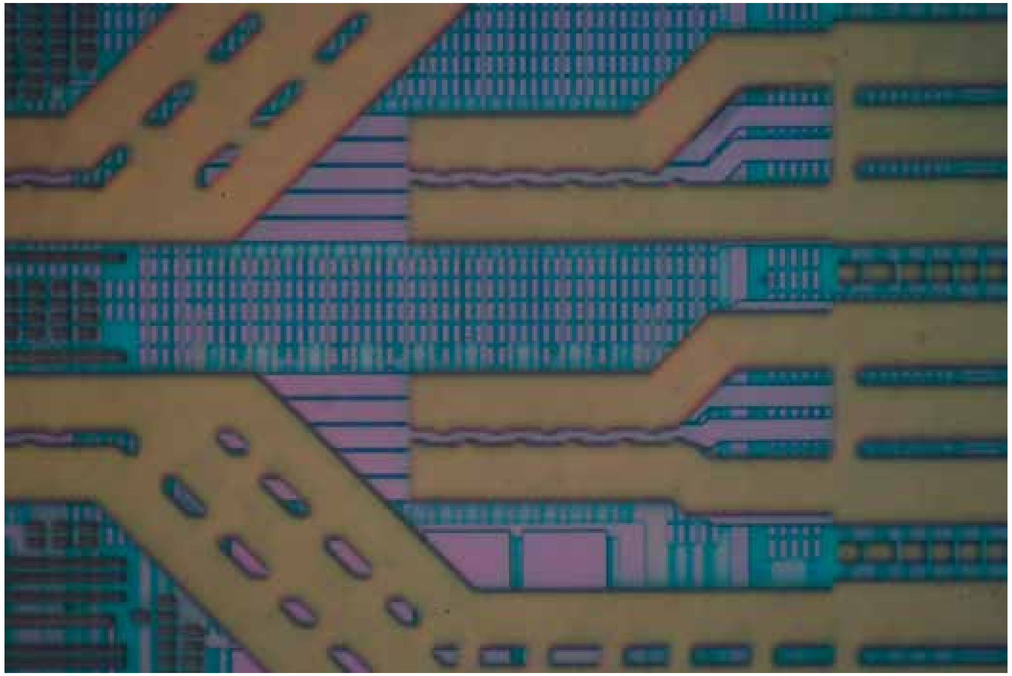
Corporate Identity

The micrograph shows a 160 x 240 µm2 detail of an integrated circuit (IC) featuring the ETH Zurich logo on its pad-ring.

The depicted IC is used for pulse oximetry and related photospectroscopic measurements. The goal of the project is to bring forward miniaturized medical devices not only to make them portable, but wearable for continuous vital signs monitoring – in everyday life or during sportive activity.

Name: Philipp Schönle
Position: PhD Student
Lab: Integrated Systems Laboratory (IIS)
Other team member: Thomas Burger, Senior Research Assistant, (IIS)

D-ITET
RESEARCH
PHOTO
COMPETITION
2016



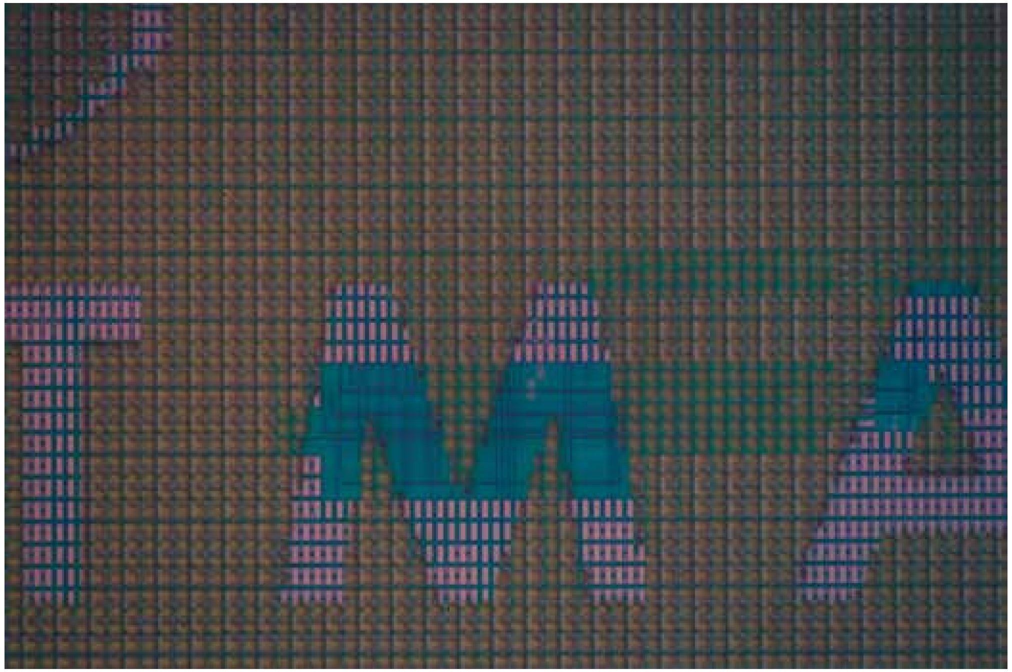
Heavy Metal

Detail (160x240µm2) of low-resistance metal connections in an IC. Focus is on the 7th metal layer (pink) while the thick 8th layer (orange) is slightly out of focus. Lower layers, most pronounced 5th and 4th, can be spotted at different locations in different shades of pink.

The depicted IC is used for pulse oximetry and related photospectroscopic measurements. The goal of the project is to bring forward miniaturized medical devices not only to make them portable, but wearable for continuous vital signs monitoring – in everyday life or during sportive activity.

Name: Philipp Schönle
Position: PhD Student
Lab: Integrated Systems Laboratory (IIS)
Other team member: Thomas Burger, Senior Research Assistant, (IIS)

D-ITET RESEARCH PHOTO COMPETITION 2016

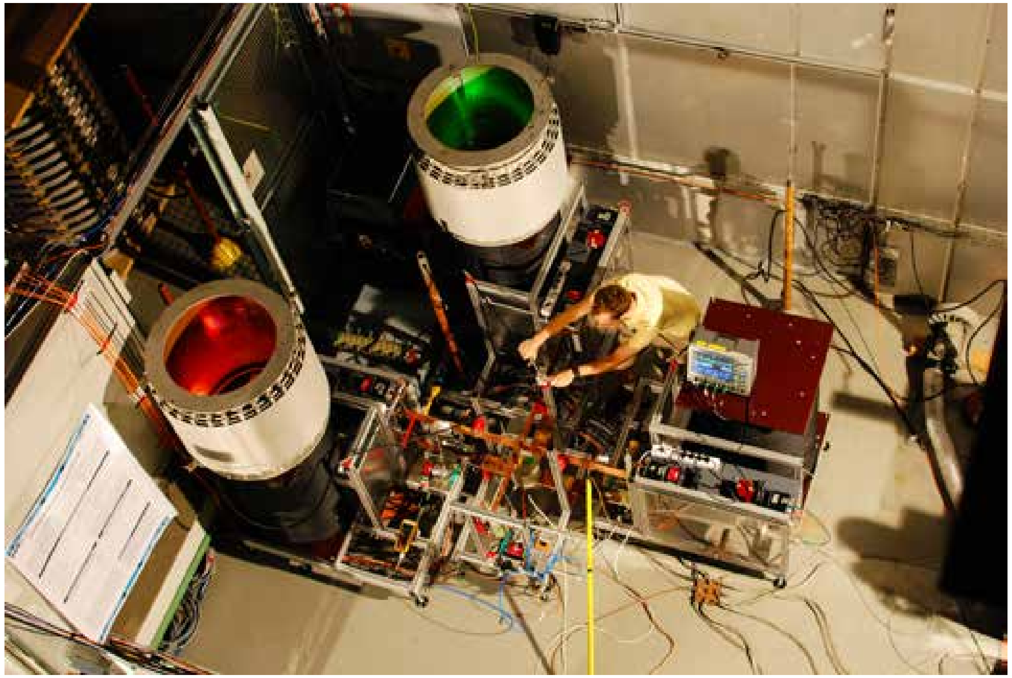


Window

The micrograph shows a 170x270μm2 detail of an IC. For process stability, unused metallization layers have to be filled with dummy patterns. In the depicted section the chip name TMA-0 is cut in the top layer. Windows in the layers below grant view on the metal interconnections of the digital circuit cells placed below. TMA-0 stands for Transimpedance Medical Amplifier for Oximetry, revealing its purpose but also being a reference to the opening scene monolithe in Stanley Kubrick's 1968 movie "A Space Odyssey".

The goal of the project is to bring forward miniaturized medical devices not only to make them portable, but wearable for continuous vital signs monitoring – in everyday life or during sportive activity.

Name: Philipp Schönle
Position: PhD Student
Lab: Integrated Systems Laboratory (IIS)
Other team member: Thomas Burger, Senior Research Assistant, (IIS)



Five Years of Pulsed Current Testing for HVDC Switchgear at ETH Zurich

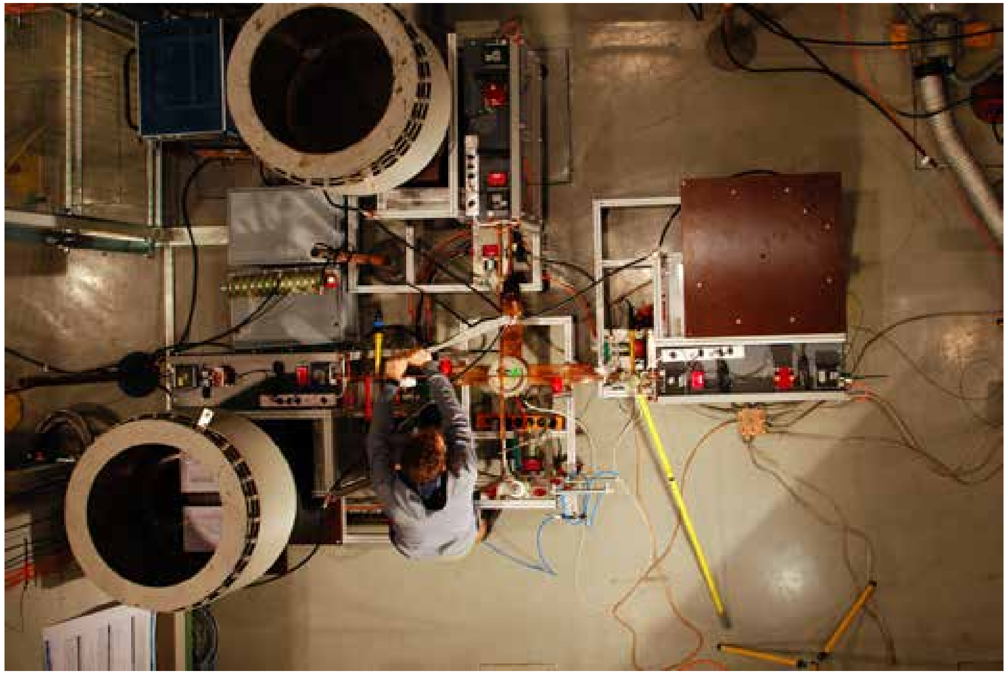
Since passing its commissioning tests in early August 2011, the flexible pulsed dc current source (FPDCS) at ETH's high voltage laboratory has enabled research in different areas of HVDC switchgear as well as its applications with an unprecedented variability and flexibility, establishing many new research opportunities. Originally, FPDCS was built to research a specific aspect of HVDC circuit-breakers, which are often referred to as the key enabling technology for wide-scale use of HVDC in Europe and across the globe. Since its inception, continuous upgrades performed by multiple PhD and master students, have made FPDCS more versatile than ever. Very few if any research institutes in the world have similar capabilities in terms of flexibility, accuracy and controllability of a DC current source.

The submitted pictures show the fascinating interplay of size, geometry and human interaction needed to operate FPDCS. The structure is composed of a multitude of small and hidden parts combined with large copper structures and eye-catching coils. A large number of cables and tubes transport supply power, control signals, measurement information and most importantly current. During normal operation, FPDCS is controlled remotely from outside of a tightly controlled safety perimeter and individual experiments only last for fractions of a second. However, when maintenance is needed or when experiment parameters need to be adjusted, human interaction involving anything from tiny screwdrivers to large cranes is necessary.

Name: Andreas Ritter
Position: PhD Student
Lab: High Voltage Laboratory (HVL)
Other team members: Tim Schultz, PhD Student (HVL) / Stefan Franz, Master Student, (HVL) / Lorenz Bort, PhD Student, (HVL)

D-ITET
RESEARCH
PHOTO
COMPETITION
2016

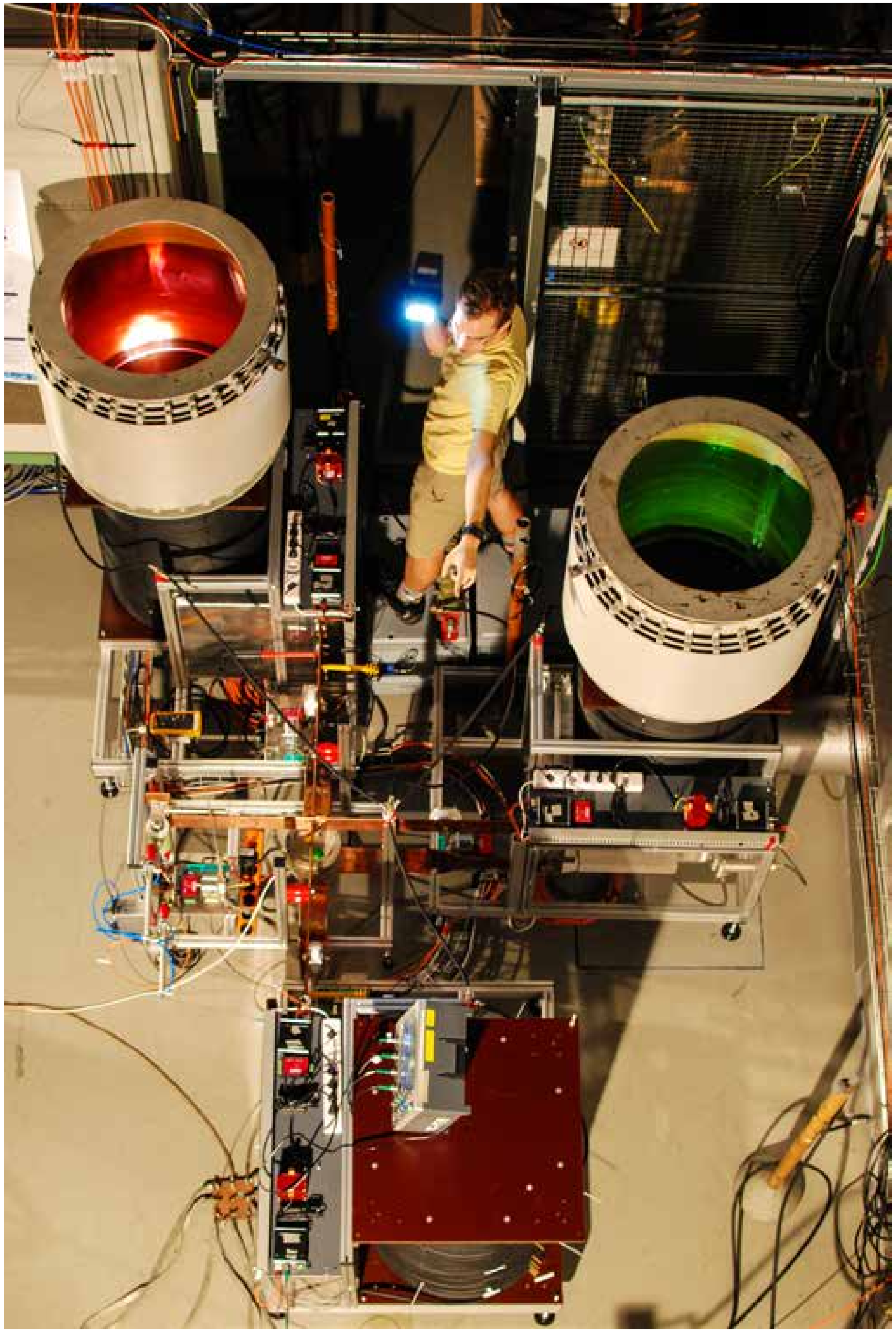
Five Years of Pulsed Current Testing for HVDC Switchgear at ETH Zurich



Since passing its commissioning tests in early August 2011, the flexible pulsed dc current source (FPDCS) at ETH's high voltage laboratory has enabled research in different areas of HVDC switchgear as well as its applications with an unprecedented variability and flexibility, establishing many new research opportunities. Originally, FPDCS was built to research a specific aspect of HVDC circuit-breakers, which are often referred to as the key enabling technology for wide-scale use of HVDC in Europe and across the globe. Since its inception, continuous upgrades performed by multiple PhD and master students, have made FPDCS more versatile than ever. Very few if any research institutes in the world have similar capabilities in terms of flexibility, accuracy and controllability of a DC current source.

The submitted pictures show the fascinating interplay of size, geometry and human interaction needed to operate FPDCS. The structure is composed of a multitude of small and hidden parts combined with large copper structures and eye-catching coils. A large number of cables and tubes transport supply power, control signals, measurement information and most importantly current. During normal operation, FPDCS is controlled remotely from outside of a tightly controlled safety perimeter and individual experiments only last for fractions of a second. However, when maintenance is needed or when experiment parameters need to be adjusted, human interaction involving anything from tiny screwdrivers to large cranes is necessary.

Name: Andreas Ritter
Position: PhD Student
Lab: High Voltage Laboratory (HVL)
Other team members: Tim Schultz, PhD Student (HVL) / Stefan Franz, Master Student, (HVL) / Lorenz Bort, PhD Student, (HVL)



D-ITET RESEARCH PHOTO COMPETITION 2016

Five Years of Pulsed Current Testing for HVDC Switchgear at ETH Zurich

Since passing its commissioning tests in early August 2011, the flexible pulsed dc current source (FPDCS) at ETH's high voltage laboratory has enabled research in different areas of HVDC switchgear as well as its applications with an unprecedented variability and flexibility, establishing many new research opportunities. Originally, FPDCS was built to research a specific aspect of HVDC circuit-breakers, which are often referred to as the key enabling technology for wide-scale use of HVDC in Europe and across the globe. Since its inception, continuous upgrades performed by multiple PhD and master students, have made FPDCS more versatile than ever. Very few if any research institutes in the world have similar capabilities in terms of flexibility, accuracy and controllability of a DC current source.

The submitted pictures show the fascinating interplay of size, geometry and human interaction needed to operate FPDCS. The structure is composed of a multitude of small and hidden parts combined with large copper structures and eye-catching coils. A large number of cables and tubes transport supply power, control signals, measurement information and most importantly current. During normal operation, FPDCS is controlled remotely from outside of a tightly controlled safety perimeter and individual experiments only last for fractions of a second. However, when maintenance is needed or when experiment parameters need to be adjusted, human interaction involving anything from tiny screwdrivers to large cranes is necessary.

Name: Andreas Ritter
Position: PhD Student
Lab: High Voltage Laboratory (HVL)
Other team members: Tim Schultz, PhD Student (HVL) / Stefan Franz, Master Student, (HVL) / Lorenz Bort, PhD Student, (HVL)

D-ITET
RESEARCH
PHOTO
COMPETITION
2016

Contactless Charging System for Future Public Transportation

Increasing public awareness of the environmental impact of greenhouse gas emissions together with the development of modern lithium-ion batteries has triggered a renewed interest in electric mobility worldwide. Together with an environmentally sustainable energy production using renewable energy sources, Electric Vehicles and Plug-in Hybrid Electric Vehicles (EV) have a smaller CO2-footprint compared to traditional vehicles that exclusively rely on internal combustion engines. As an additional advantage, the total cost of ownership over the lifetime of EV is lower than that of traditional vehicles despite the higher initial purchase price. Hence, vehicle markets of the developed world have seen EV sales rapidly increasing over the past years.

Inductive Power Transfer is widely considered as an alternative to conventional conductive Electric Vehicle battery chargers for the unique advantages of the contactless power supply. The power electronics design tradeoffs between the automotive requirements of high efficiency, high compactness, and low stray field for inductive power transfer systems were analyzed in this project.

The photo shows the prototype of a 50 kW contactless EV charging system. The power electronic converter on the left controls the power flow from one coil to the other. A plexiglass table is used to support the receiver coil at a distance of 160 mm from the transmitter coil.

Name: Roman Bosshard
Position: Postdoc
Lab: Power Electronic Systems Laboratory (PES)
Other team members: Christoph Gammeter, PhD Student, (PES) /
Arda Tüysüz, Postdoc, (PES)

D-ITET RESEARCH PHOTO COMPETITION 2016

Examination of an overhead line conductor

The goal is to deliver the necessary know-how that allows the grid operator to better estimate the current capacity of each line in the Swiss transmission network (AAAC) dependent on actual weather conditions. The flexibility, efficiency, reliability as well as lifetime prediction can be improved. Therefore, the electrical-thermal-mechanical limits of the conductor are investigated in detail.

A wedge clamp suspends the stranded conductor to the pylon. In that zone, elevated stresses and strains occur. This can be critical for failure. Therefore, the beneficial cooling effects of the clamp are investigated thoroughly as it may improve future clamp designs. As the changed current density distribution at the wedge clamp influences the temperature, said distribution can be evaluated by measuring the magnetic field as shown in the picture.

The results of this study contribute to safer and more cost effective operation of the transmission grid, which is crucial for present and future energy demand in our society.

Name: Pascal Buehlmann
Position: Scientific Assistant, PhD Student
Lab: High Voltage Laboratory (HVL)

D-ITET RESEARCH PHOTO COMPETITION 2016

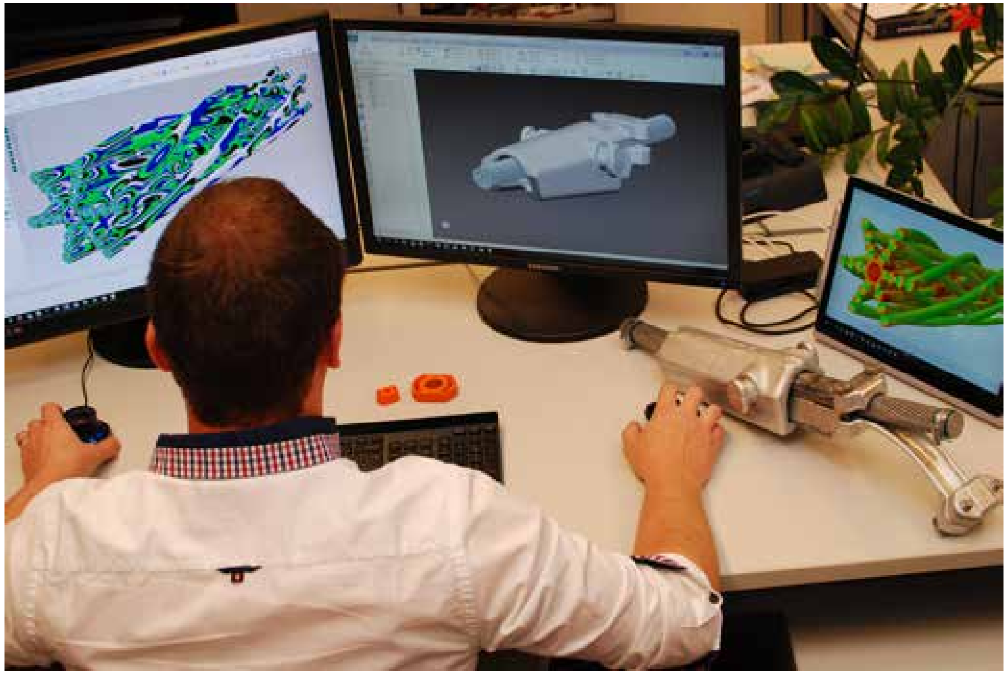
Examination of an overhead line conductor

The goal is to deliver the necessary know-how that allows the grid operator to better estimate the current capacity of each line in the Swiss transmission network (AAAC) dependent on actual weather conditions. The flexibility, efficiency, reliability as well as lifetime prediction can be improved. Therefore, the electrical-thermal-mechanical limits of the conductor are investigated in detail.

A wedge clamp suspends the stranded conductor to the pylon. In that zone, elevated stresses and strains occur. This can be critical for failure. Therefore, the beneficial cooling effects of the clamp are investigated thoroughly as it may improve future clamp designs. As the changed current density distribution at the wedge clamp influences the temperature, said distribution can be evaluated by measuring the magnetic field as shown in the picture.

The results of this study contribute to safer and more cost effective operation of the transmission grid, which is crucial for present and future energy demand in our society.

Name: Pascal Buehlmann
Position: Scientific Assistant, PhD Student
Lab: High Voltage Laboratory (HVL)



Modelling structural changes of an overhead-line conductor

The goal is to deliver the necessary know-how that allows the grid operator to better estimate the current capacity of each line in the Swiss transmission network (AAAC) dependent on actual weather conditions. The flexibility, efficiency, reliability as well as lifetime prediction can be improved. Therefore, the lectrical-thermal-mechanical limits of the conductor are investigated in detail.

The shown modelling process aim to determine the mechanical stresses and structural changes of the stranded conductor near the wedge clamp, where all tensile force of the line is suspended by the pylon. Thus, the zone of this clamp with elevated stresses and strains can be critical for failure.

The results of this study contribute to safer and more cost effective operation of the transmission grid, which is crucial for present and future energy demand in our society.

Name: Pascal Buehlmann
Position: Scientific Assistant, PhD Student
Lab: High Voltage Laboratory (HVL)

D-ITET
RESEARCH
PHOTO
COMPETITION
2016

Gases that capture electrons

Photography of the inside of a gas vessel, featuring two nickel-plated electrodes. The openings of the vessel are reflected onto the electrodes, giving the illusion that the latter have holes in them. The reason why the electrodes are so smooth and rounded is to create a perfectly homogenous electric field in their center. In this experiment, a UV laser pulse releases up to 10 million electrons from the left electrode. The electric field accelerates the electrons through the gas towards the right electrode. The fastest electrons may ionize gas molecules and free new electrons, which in turn ionize other molecules. An electrical discharge has been initiated. However, some molecules have the ability to capture electrons, thus chocking off electrical discharges. This ability is exactly what is needed for a gas to be a good electrical insulator such as the widely-used sulfur hexafluoride (SF6), which is one of the strongest known greenhouse gases. Our research project aims to identify new gases with low global warming potential that could replace SF6 in the electrical equipment necessary for the energy transmission and distribution systems.

Name: Alise Chachereau
Position: PhD Student
Lab: High Voltage Laboratory (HVL)
Other team members: Pascal Häfliger / Mohamed Rabie / Andreas Hoesl / PhD Students, (HVL)

Special Prize «Technology»

D-ITET
RESEARCH PHOTO COMPETITION
2016

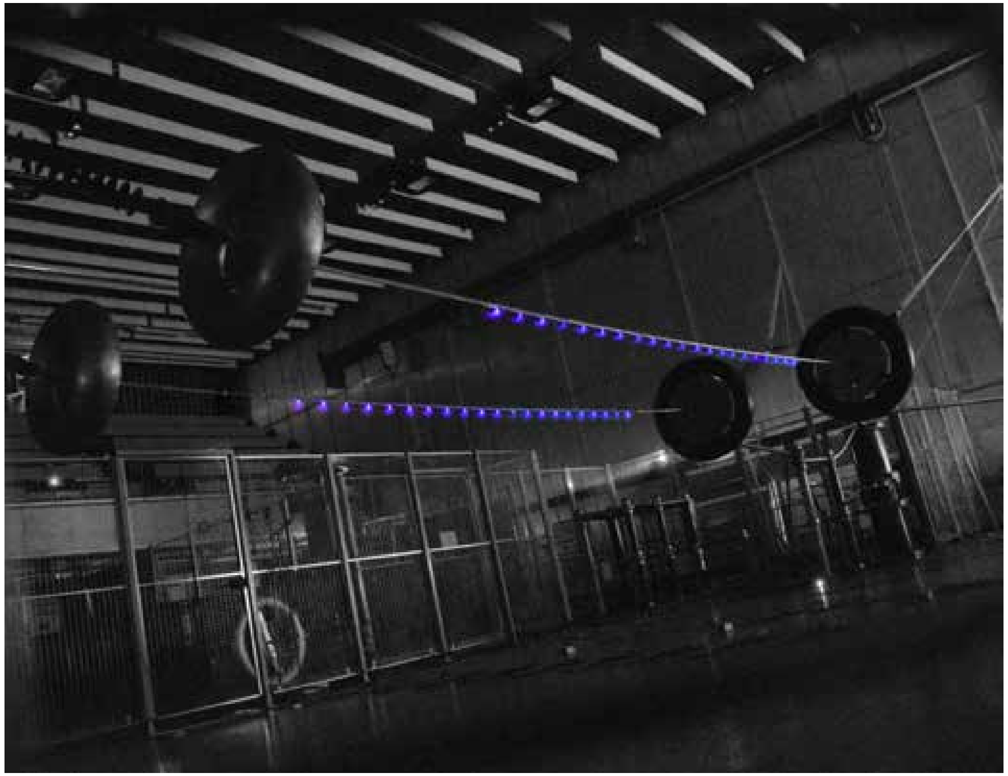
From medium-voltage to low-voltage: compact and efficient

The increase of the electrical energy consumption requires new solutions for efficient energy conversion in applications such as railway electric traction, datacenters, smart grids, or large renewable power plants where the utilization of medium-voltage allows the reduction of the transmission losses. Therefore, compact, lightweight, efficient, and versatile (AC, DC, three-phase, etc.) power converters are required. For fulfilling these requirements, it is necessary to overcome the physical limitations of transformers, which is done by the association of magnetic circuits with power semiconductors, forming the Solid-State Transformer concept.

The photograph depicts a high-power converter converting 2kV DC voltage to 400 V. This converter, which is only 50 cm long, can convert 166 kW, which is the power required by 2500 laptops. This converter is part of a 1 MW / 12 kV system composing the traction chain of future electric trains. The prototype is composed of two semiconductors bridges (front/back) connected together by a medium-frequency (20 kHz) transformer (center), which features water cooling. Finally, the control and driving electronic can be seen (top/front).

Name: Thomas Guillod
Position: PhD Student
Lab: Power Electronic Systems Laboratory (PES)
Other team member: Dr. Gabriel Ortiz, former PhD Student, (PES)

D-ITET RESEARCH PHOTO COMPETITION 2016



Impact of interferences on the environmental effects of hybrid AC/DC transmission lines

Our team is investigating the concept of the conversion of conventional overhead lines to hybrid transmission lines carrying alternating and direct current on the same tower. Due to the higher transmission capacity and efficiency of the converted tower, the construction of a new line can be avoided.

For the project "UltraNet" in Germany, this concept is about to be realized for the first time world-wide in the next 5-10 years. This concept is now also being evaluated by Swissgrid and other international grid operators (TSOs) as a solution to increase public acceptance for the required grid expansion. Therefore, this acceptance is crucial for a fast implementation in order to strengthen the grid for the increasing load and share of fluctuating renewable energy sources.

Together with these TSOs, our team is developing prediction models for environmental effects of such lines as electromagnetic fields and audible noise. Based on these models, an optimized arrangement will be proposed in order to reduce these effects to an acceptable minimum.

Name: Sören Hedtke
Position: PhD Student
Lab: High Voltage Laboratory (HVL)
Other team members: Martin Pfeiffer, PhD Student, (HVL)
Tim Schultz, PhD Student, (HVL)

D-ITET RESEARCH PHOTO COMPETITION 2016

Impact of interferences on the environmental effects of hybrid AC/DC transmission lines

Our team is investigating the concept of the conversion of conventional overhead lines to hybrid transmission lines carrying alternating and direct current on the same tower. Due to the higher transmission capacity and efficiency of the converted tower, the construction of a new line can be avoided.

For the project "UltraNet" in Germany, this concept is about to be realized for the first time world-wide in the next 5-10 years. This concept is now also being evaluated by Swissgrid and other international grid operators (TSOs) as a solution to increase public acceptance for the required grid expansion. Therefore, this acceptance is crucial for a fast implementation in order to strengthen the grid for the increasing load and share of fluctuating renewable energy sources.

Together with these TSOs, our team is developing prediction models for environmental effects of such lines as electromagnetic fields and audible noise. Based on these models, an optimized arrangement will be proposed in order to reduce these effects to an acceptable minimum.

Name: Sören Hedtke
Position: PhD Student
Lab: High Voltage Laboratory (HVL)
Other team members: Martin Pfeiffer, PhD Student, (HVL)
Tim Schultz, PhD Student, (HVL)

D-ITET
RESEARCH
PHOTO
COMPETITION
2016

Solid-state transformers for smart grids, future trains and ships

The picture shows a partly assembled hardware prototype of a lab-scale Solid-State Transformer (SST) demonstrator system. SSTs can replace conventional low-frequency transformers to provide isolated medium-voltage to low-voltage conversion in applications where weight and space are limited, e. g., in nacelles of wind turbines, in traction vehicles, or aboard future all-electric ships and all-electric aircraft, because the higher operating frequency of the isolation transformers facilitates higher power densities. Furthermore, a high degree of controllability motivates the application of SSTs also in future smart distribution grids, where the technology could help handling the challenges that are created from an increased share of renewable energy sources connected to the grid at lower voltage levels, such as, e.\,g., residential PV installations. The lab-scale SST demonstrator facilitates the analysis and optimization of control strategies and control algorithms for full-scale SST systems in a highly realistic environment.

Name: Jonas Huber
Position: PhD Student
Lab: Power Electronic Systems Laboratory (PES)

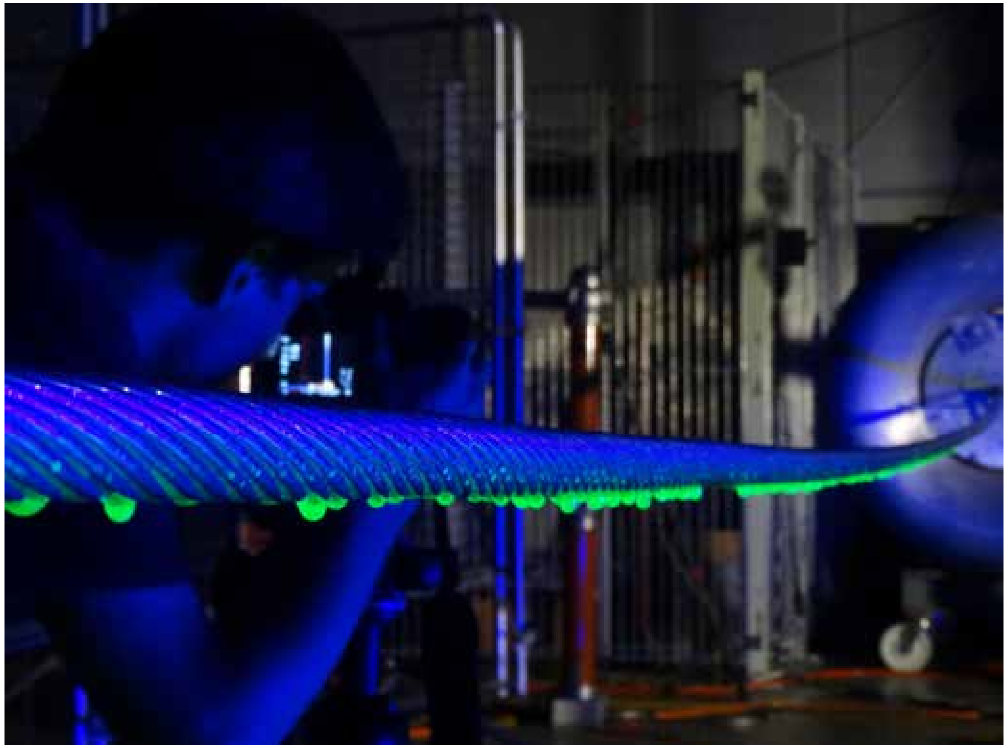
D-ITET
RESEARCH
PHOTO
COMPETITION
2016

Solid-state transformers for smart grids, future trains and ships

The picture shows a partly assembled hardware prototype of a lab-scale Solid-State Transformer (SST) demonstrator system. SSTs can replace conventional low-frequency transformers to provide isolated medium-voltage to low-voltage conversion in applications where weight and space are limited, e. g., in nacelles of wind turbines, in traction vehicles, or aboard future all-electric ships and all-electric aircraft, because the higher operating frequency of the isolation transformers facilitates higher power densities. Furthermore, a high degree of controllability motivates the application of SSTs also in future smart distribution grids, where the technology could help handling the challenges that are created from an increased share of renewable energy sources connected to the grid at lower voltage levels, such as, e.\,g., residential PV installations. The lab-scale SST demonstrator facilitates the analysis and optimization of control strategies and control algorithms for full-scale SST systems in a highly realistic environment.

Name: Jonas Huber
Position: PhD Student
Lab: Power Electronic Systems Laboratory (PES)

D-ITET
RESEARCH
PHOTO
COMPETITION
2016



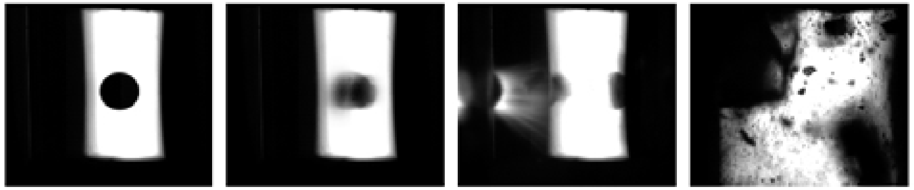
High voltage water drops

Our team is investigating the environmental effects of a novel power transmission technology: hybrid AC/DC transmission. The main idea is to convert existing AC transmission corridors (this is the state of the art power transmission technology in Europe today) to systems in which AC and DC lines are used on the same tower. This can significantly increase the power throughput of an existing corridor and can delay or prevent the construction of new overhead lines. This concept will be implemented in Germany in the coming years in a project called "Ultranet" – the first of its kind worldwide. Our team is supporting this project by investigating fundamental effects in the areas of electromagnetic fields and noise emissions. Water on the lines plays a crucial role with regard to these effects. We therefore analyze the distribution and shape of water drops by adding a UV sensitive substance to the water.

Name: Martin Pfeiffer
Position: PhD Student
Lab: High Voltage Laboratory (HVL)
Other team members: Tim Schultz, PhD Student, (HVL) /
Sören Hedtke, PhD Student, (HVL)

2nd prize

D-ITET
RESEARCH
PHOTO
COMPETITION
2016

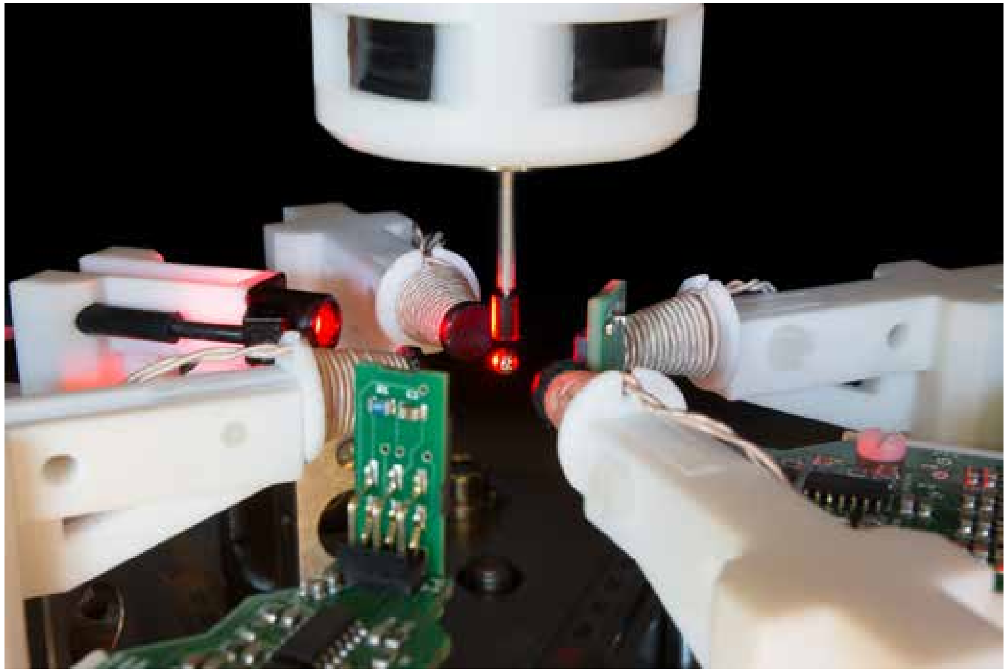


Explosion at 20'000'000 rotations per minute

The image shows a time series of photographs that has been recorded using a high-speed camera at 300'000 frames per second, which is approximately 60'000 times faster than the blink of an eye. It displays the explosion of the rotor in the world's fastest electric motor, which is capable of reaching rotational speeds beyond 40'000'000 rotations per minute and has been developed by the Power Electronic Systems Laboratory (PES) at the D-ITET. The first frame depicts the shadow (black circle) of the intact rotor of only 0.8 mm in diameter, which is freely levitated and rotating at slightly more than 20'000'000 rotations per minute. Soon after (second frame), it is split into multiple pieces which fly away with a speed of approximately 600 m/s (~ 1.8 times the speed of sound). In the third frame, these pieces hit the wall of a surrounding glass tube and destroy it, leading to the flying glass particles as shown in frame four. The process of rotor material failure under extreme centrifugal loading provides valuable insights for material scientists to develop new, more durable materials and offers physicists the possibility to study the behavior of matter under extreme conditions.

Name: Marcel Schuck
Position: PhD Student
Lab: Power Electronic Systems Laboratory (PES)

D-ITET RESEARCH PHOTO COMPETITION 2016



The world's fastest electric motor

The photo shows a close-up view of the world's fastest electric motor, which has been developed by the Power Electronic Systems Laboratory (PES) at the D-ITET. It is able to reach rotational speeds of more than 40'000'000 rotations per minute, which is the world record for the highest rotational speed ever achieved by such a machine – in comparison, a car engine rotates at less than 10'000 rotations/minute. To achieve such high speeds, a very small sphere with a diameter of less than 1 mm is used as a rotor, which is freely levitated without friction by using electromagnets. At full speed, a point at the equator of the sphere reaches a speed of more than 3000 km/h. The developed system can be used in materials testing applications and the underlying research paves the way for ultra-compact and highly efficient electrical drives, which are essential to creating a sustainable energy future.

Name: Marcel Schuck
Position: PhD Student
Lab: Power Electronic Systems Laboratory (PES)

Special Prize «Technology»

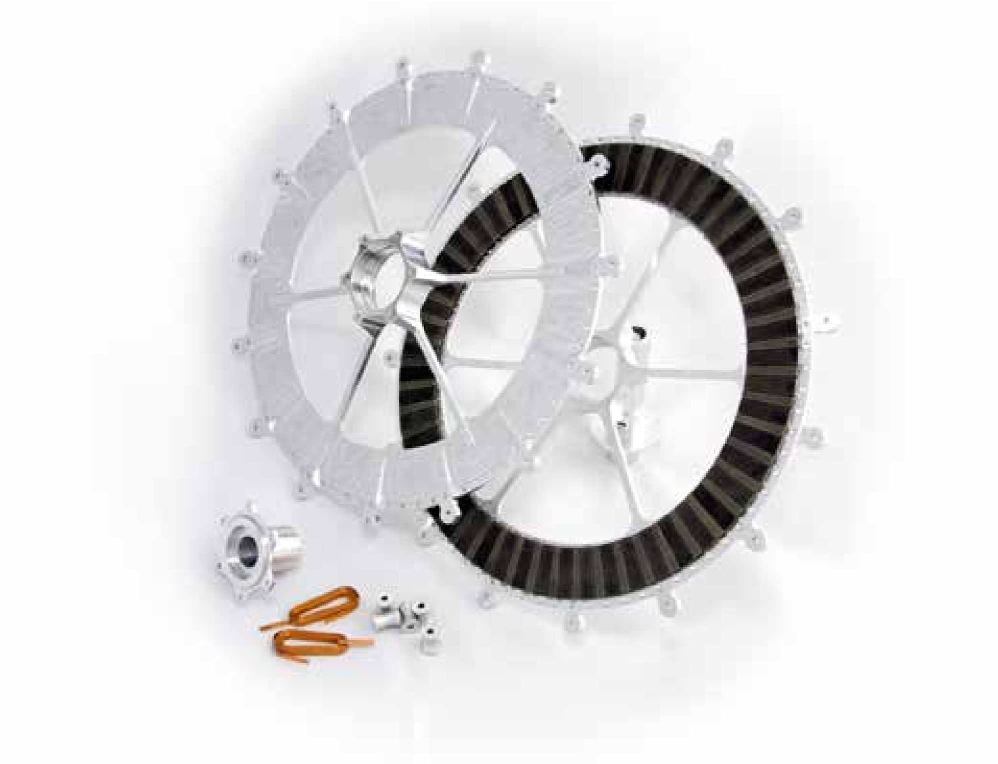
D-ITET RESEARCH PHOTO COMPETITION 2016

The destructive force of high voltage arcs

The increasing share of volatile renewable energy sources as well as the rising demand for electricity make a safe and reliable operation of the power grid more and more challenging. High voltage direct current (HVDC) may be used to upgrade the transmission capability of today's alternating current networks. For a safe and reliable operation of HVDC grids, circuit breakers are necessary. However, in contrast to alternating current, the interruption of direct currents still remains a major challenge. The picture shows the impact of short circuit current on the contacts of a scaled down circuit breaker model. While lasting for less than the blink of an eye, the destructive forces of the arc melt the surface of the electrodes and vaporize the surface of the surrounding nozzle. The aim of the conducted experiments is to test the performance of circuits that are developed to break fault currents in future HVDC networks.

Name: Tim Schultz
Position: PhD Student
Lab: High Voltage Laboratory (HVL)
Other team member: Thomas Ziemann, PhD Student, (APS)

D-ITET
RESEARCH
PHOTO
COMPETITION
2016



An aircraft built to produce electricity – strong winds are no longer unreachable

Ground level winds (below 100 m) are slow and weak and this is the main reason why, despite the high demand, the wind currently produces only 3% of the world energy. Incomparably stronger winds which reside at higher altitudes (200-600 m) above ground are unfortunately beyond the reach of conventional wind turbines.

Although an aircraft flying and generating electricity would be able to utilize strong winds, a high mass of its generator (electrical machine) was until present making this topology unfeasible in the real world.

However, the research within Power Electronic Systems Laboratory (PES) revealed that the weight of the electrical machine can be halved (without decreasing its power) in comparison to best solutions available in industry and those reported in literature.

The figure depicts parts of an extremely light-weight (2 kg) and powerful (12.5 kW) electrical machine designed for airborne wind turbines. It clearly demonstrates the feasibility of this topology, which can lead to airborne wind turbines winning the race over conventional wind turbines for being a global energy supplier.

Name: Ivan Subotic
Position: Postdoc
Lab: Power Electronic Systems Laboratory (PES)
Other team members: Christoph Gammeter, PhD Student, (PES) /
Arda Tüysüz, Postdoc, (PES)

D-ITET
RESEARCH
PHOTO
COMPETITION
2016

Harvesting the power of a massive wheel

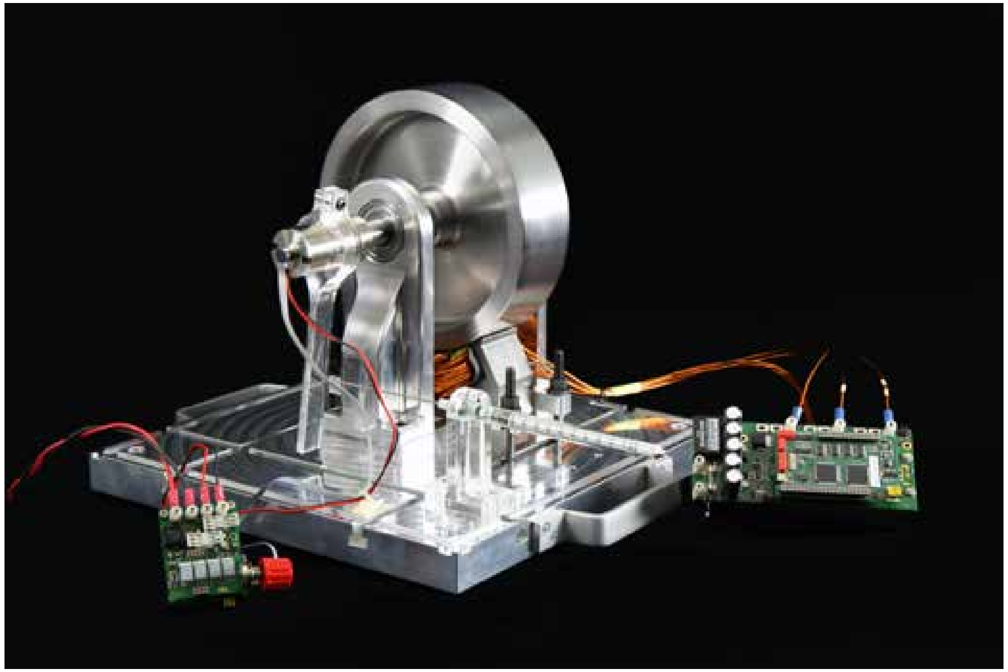
The photograph depicts the laboratory test setup we have developed for testing different electromechanical energy harvesting concepts. Energy harvesting is the process of utilizing ambient energy sources for power supply purposes, e.g. for locally supplying devices such as sensors and actuators. In literature, temperature gradients, radiation, mass flow and kinetic energy have all been utilized for energy generation.

However, today the term energy harvesting usually relates to micro- or milliwatt power levels. In our project, we aim towards more than x1000 increase in the power level for opening up a fascinating new area of remote, self-powered sensor and/or actuator systems.

We consider the harvesting of electrical power from the kinetic energy of a moving, electrically conductive object, without mechanical contact. Hence, electrical energy can be generated locally in the vicinity of endless industrial components, such as manufacturing machines, gears, conveyor belts and large shafts. This in turn omits the effort and cost of electrical installation and will be an enabling technology for the implementation of smart machines connected in the Internet of Things for the Industry 4.0.

Name: Arda Tüysüz
Position: Post-Doctoral Researcher
Lab: Power Electronic Systems Laboratory (PES)
Other team member: Michael Flankl, PhD Student, (PES)

D-ITET
RESEARCH
PHOTO
COMPETITION
2016



Harvesting the power of a massive wheel

The photograph depicts the laboratory test setup we have developed for testing different electromechanical energy harvesting concepts. Energy harvesting is the process of utilizing ambient energy sources for power supply purposes, e.g. for locally supplying devices such as sensors and actuators. In literature, temperature gradients, radiation, mass flow and kinetic energy have all been utilized for energy generation.

However, today the term energy harvesting usually relates to micro- or milliwatt power levels. In our project, we aim towards more than x1000 increase in the power level for opening up a fascinating new area of remote, self-powered sensor and/or actuator systems.

We consider the harvesting of electrical power from the kinetic energy of a moving, electrically conductive object, without mechanical contact. Hence, electrical energy can be generated locally in the vicinity of endless industrial components, such as manufacturing machines, gears, conveyor belts and large shafts. This in turn omits the effort and cost of electrical installation and will be an enabling technology for the implementation of smart machines connected in the Internet of Things for the Industry 4.0.

Name: Arda Tüysüz
Position: Post-Doctoral Researcher
Lab: Power Electronic Systems Laboratory (PES)
Other team member: Michael Flankl, PhD Student, (PES)

D-ITET
RESEARCH PHOTO COMPETITION
2016

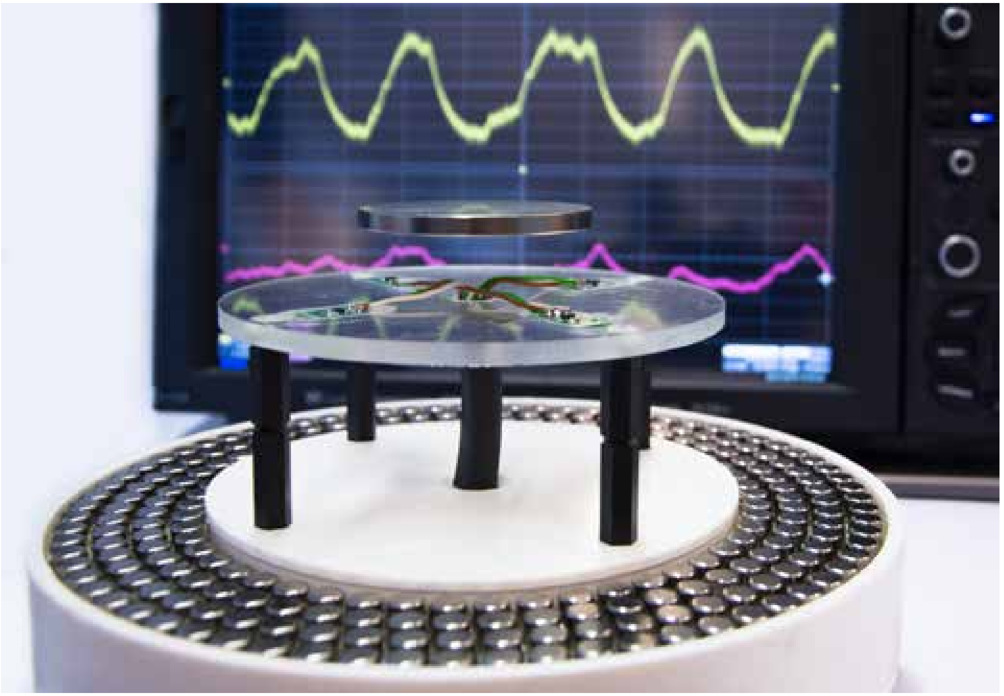
Faster, smaller and more-accurate satellite attitude control systems with magnetic levitation

Researchers of ETH Zurich and ETH spin-off Celeroton are seen in this image working on the novel, high-speed, magnetically levitated reaction wheel motor that has been jointly developed.

Due to their lower launching cost and ability to perform certain tasks that are not suitable for larger satellites, micro-, nano-, or even pico-satellites are gaining in popularity for a wide range of space missions such as such as high-resolution Earth imaging or communication. Most of today's reaction wheels use ball bearings, where mechanical wear limits the rotating speeds to around 6 000 rpm. Moreover, ball bearings generate microvibrations, which decrease the positioning accuracy – a very important performance criteria in several high-precision space missions. In this project, we have developed a novel high-speed motor using magnetic bearings, such that the microvibrations can be eliminated. Furthermore, the contact-free nature of magnetic bearings allowed us to reach speeds up to 150 000 rpm, which results in an immense reduction of size and weight – another huge advantage in satellites.

Name: Arda Tüysüz
Position: Post-Doctoral Researcher
Lab: Power Electronic Systems Laboratory (PES)
Other team member: Christof Zwyssig, former PhD Student, (PES),
co-founder of ETH Spin-off Celeroton AG

D-ITET
RESEARCH
PHOTO
COMPETITION
2016



Who said that UFOs don't exist?

The image shows a technology demonstrator for magnetic levitation over wide distances – the levitated magnet hovers freely in space, just like an UFO. The system consists of a base station, containing 192 permanent magnets, actuators and sensors, as well as a single levitating magnet. Different magnets can be levitated using the same base station. The novelty of this system is the fact that the airgap, which is the distance between the base and the levitating magnet, is very wide compared to the diameter of the magnet. The depicted system was designed, manufactured and commissioned by two master students during a three month research project.

Similar levitation technology can be used in electric motors to support rotating parts without the use of mechanical bearings. Using such magnetic bearings offers a variety of advantages, such as very low friction, no wear, no particle generation and a long lifetime. Such motors are usually employed in applications that demand for high rotational speeds or low contamination such as flywheels or pumps for the semiconductor and pharmaceutical industry.

Name: Tobias Wellerdieck
Position: PhD Student
Lab: Power Electronic Systems Laboratory (PES)
Other team members: Laurianne Prongué, MSc Student / Marc Herzog, MSc Student / Marcel Schuck, PhD Student, (PES)