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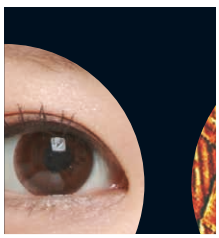
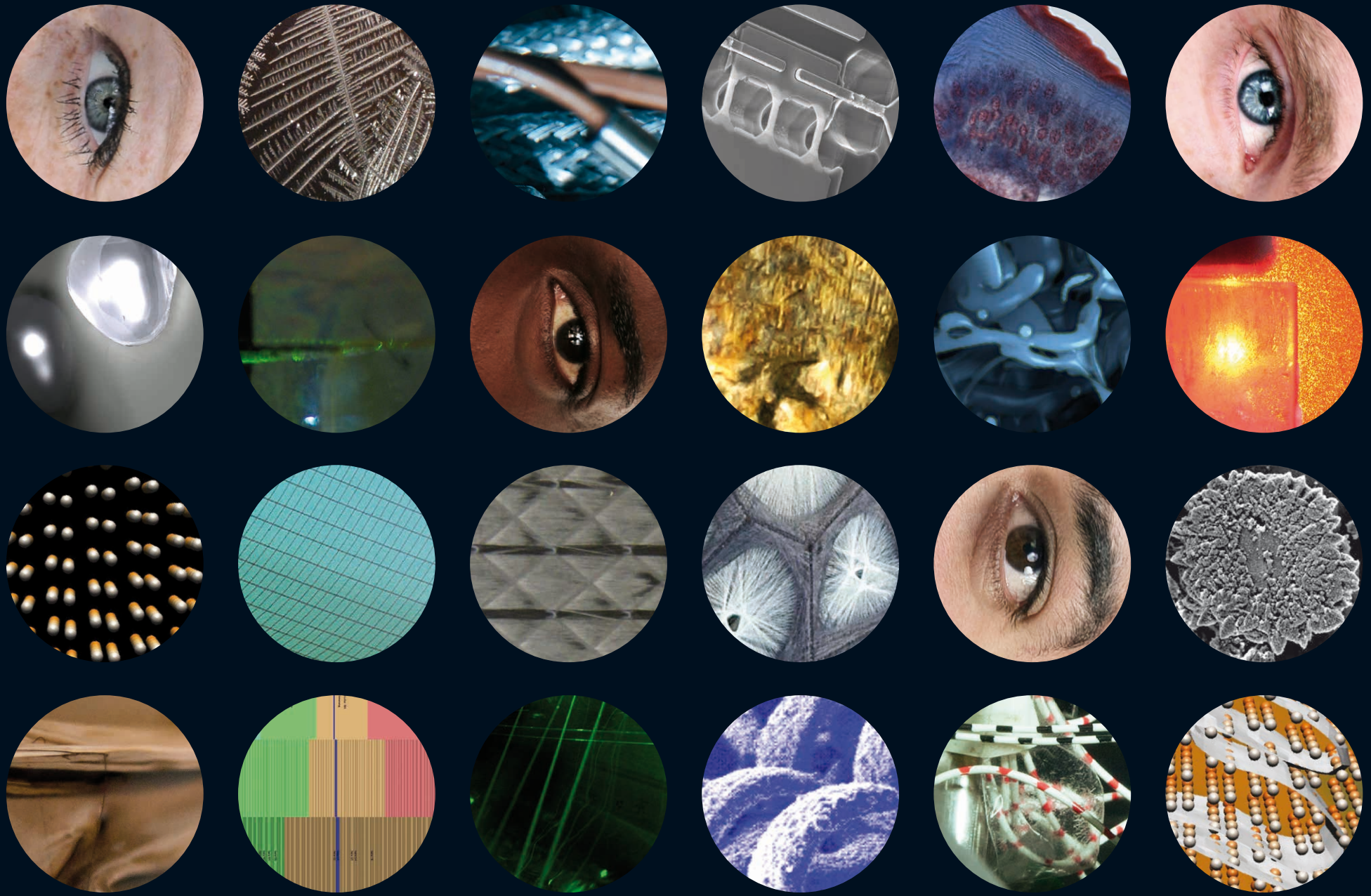
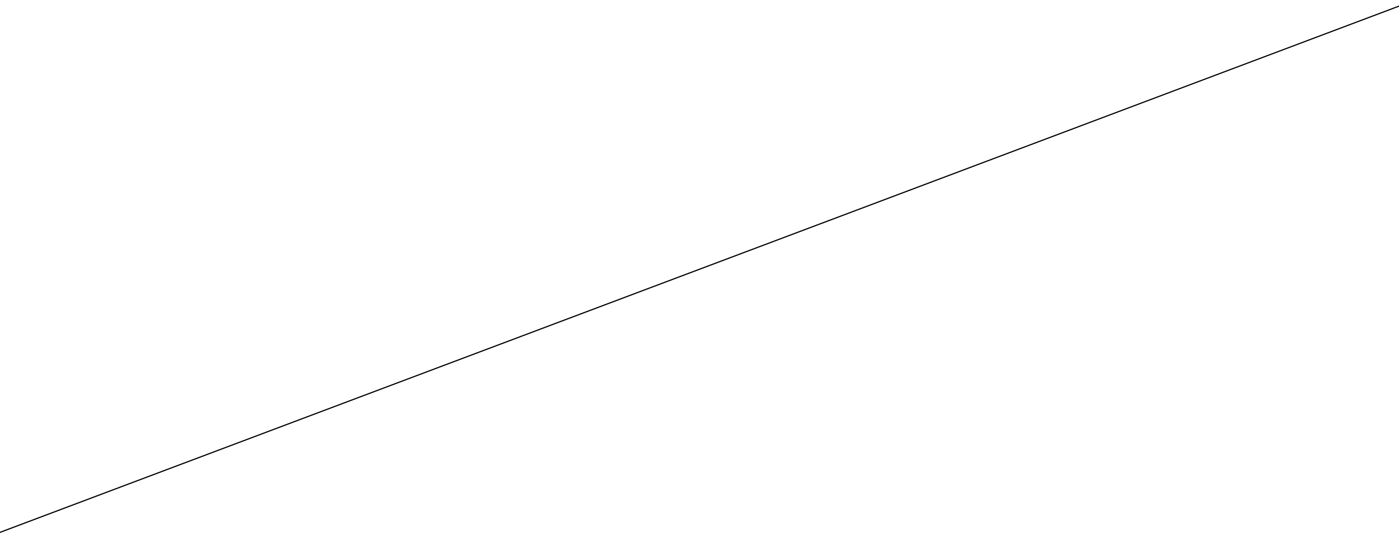


SCIENCE BRINGS THE WORLD TOGETHER

THE MAGAZINE OF THE UNIVERSITY OF STUTTGART 05 | 2015

Universität Stuttgart





A cordial welcome to all our readers!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Wolfram Ressel
Rector of the University of Stuttgart

When our editorial team started thinking about the basic concept for this issue of our University's magazine RESEARCH AND LIFE, it wasn't long before the timeliness of our planned topic, "Science Brings the World Together", really dawned upon us. Our aim was to take various examples from the University of Stuttgart's life and work to show how the fundamental guidelines for all branches of learning down to the present day have always included openness to the world, an international point of view, and tolerance. Now, in light of the huge numbers of refugees coming this year to Europe and to Germany above all in a search for asylum and protection, our topic has assumed a new dimension of critical importance.
As you will see, the following texts center around global cooperation and international dialogue; they show clearly that the branches of learning, with their tradition of bringing different cultures and religions together in respectful collaboration, can make an important contribution to the support of refugees and their integration. In line with this insight, universities all over Germany have initiated immediate action to provide assistance and open their academic doors to refugees. The students, too, have shown a constant readiness to involve themselves in international projects. In the article "A World Under Construction", for example, you will learn how international work begins even during the years of study and how student activities involving architecture and urban development are including refugee projects. Professor Margret Wintermantel's article has keynote importance; in her capacity as President of the German Academic Exchange Service (DAAD) she describes how "Science Brings the World Together" by driving research and innovation. And the article on the University of Stuttgart's internationalisation strategy aims to inform you about Stuttgart's "Roadway to a Global Society". Many other articles below on research into clean water, earthquakes, and energy in and for various countries and about political advisory services at the World Climate Summit round out our spectrum of topics. Common to all these discussions is that they show how research and teaching are averse to any form of better-than-thou-thinking and are incompatible with resentments and prejudice.

We wish you much enjoyment in reading our magazine and welcome your comments!

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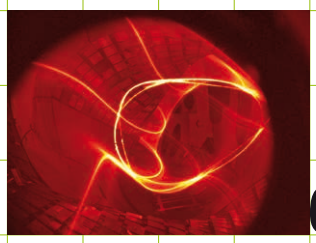
Picture sources: Uli Regenscheit, DAAD/Eric Lichterscheidt, Jens Eber, PI 4, CERN, IPP/Matthias Otte

Research and Life



... Heard in Passing

PEGASUS LENDS WINGS TO CHEMISTRY AND TECHNICAL BIOLOGY

Ground was broken on August 19, 2015 for the new "Pegasus" building (Practical Annex and New Wing of the University of Stuttgart), which will be home first and foremost to the Institute for Biochemistry. This new building will provide optimum learning conditions above all to students of chemistry and technical biology at the University of Stuttgart. Not only will they acquire a comprehensive knowledge of general biochemistry but they can also gain expertise in allied fields like cellular biology, systems biology, synthetic biology and molecular epigenetics. The University of Stuttgart also sets a signpost in research policy here too, since molecular biology is expected to revolutionize the field of medicine in the coming decade.

RESERVOIR MANAGEMENT

Reservoirs are important in helping to ensure a supply of water and energy. A new network named CHARM (Challenges of Reservoir Management) is studying five major challenges in the operation and management of reservoirs: sedimentation, the emergence of microbial films, the growth and propagation of blue-green algae, methane gas emissions, and social conflicts. This makes it necessary to take up socioeconomic and ecological problems as well in order to ensure the sustained functionality of reservoirs. This network, supported to the tune of two million Euros by the Federal State of Baden-Württemberg, brings together for the first time ever the expertise of the Universities of Stuttgart (sediment research), Constance (algae and methane gas research), and Freiburg (societal research). Spokeswoman is Professor Silke Wieprecht of the University of Stuttgart.

QUANTITATIVE LITERATURE STUDIES

Who says literature has nothing to do with mathematics? Quite the contrary! Dr. Toni Bernhart heads up a new project funded in part by the German Research Foundation (DFG) and named "Quantitative Literature studies" to study when and why scientists in past centuries have used mathematics and statistics - i.e. quantitative methods - to study and interpret literature and language. These lines of research and historical study provide lay the groundwork for Digital Humanities. The project brought Toni Bernhart from the Free University of Berlin to the University of Stuttgart's Institute for Literary studies (headed by Professor Andrea Albrecht), where he will work closely with the Stuttgart Research Center for Textual studies.

Cooperation...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SYSTEMATIZING THE ENERGY REVOLUTION

An efficient, sustainable supply of energy is not enough to ensure the success of the Energy Revolution. Even more important is to shape a long-term, complex transformation process with an overview which integrates the technical, economic, ecological and social dimensions into a single overview. Systems analysis can achieve this, as several institutes at the University of Stuttgart have realized. For example, the Center for Solar Energy and Hydrogen Research of Baden-Württemberg (ZSW) and the German Center for Aerospace Engineering (DLR) are combining their systems research capacities at the University of Stuttgart in order to arrive at a more comprehensive view of issues raised by the Energy Revolution. “The aim is to integrate not only ecological and economic aspects but social factors as well into our analyses,“ says the alliance's University of Stuttgart spokesman, Professor Kai Hufendiek. In this way the two partners are making an important contribution to successfully shaping the energy system of the future and underscoring even more the active power of the Federal State of Baden-Württemberg as a leading region in the Energy Revolution.“

The Winners


© Rennteam

LIGHTNING-FAST AND INNOVATIVE

The University of Stuttgart's race car drivers - particularly the women! - can look back on an extremely successful season: the racing car team won the Student Formula Race Car Competition in Spain in August and climbed the steps to the winners' podium with a possible world record overall score of 980.15 points. Two sisters, Helena and Valerie Ortwein, won the business presentation, and two other sisters, Anita and Diana Karadzic (Photo), scored with their cost report. The GreenTeam won back for Germany the world record for acceleration in electrically-powered vehicles. At the end of a series of acceleration trials during the “Jade-Race“ in Mariensiel near Wilhelmshafen in July, students from the University of Stuttgart broke the previous Swiss record by rocketing from 0 to 100 km/h in 1.779 seconds. At the 2015 Aeolus Race, the world championship for ventomobiles (i.e. crosswind vehicles), students from Team InVentus not only took third place overall but also won the prize for the most innovative vehicle. After only one year of development, the team from Stuttgart brought to the starting line the world's first crosswind vehicle with a hybrid drive train: an electric energy transfer system in addition to a conventional, purely mechanical energy transfer system, thus making optimum use of all available energy.

THE EARLY BIRD ...

During "TU9-Ing" week in September, pupils from German schools abroad and foreign language diploma schools had a chance at the University of Stuttgart to dip their toes into the world of academic study and get a first glimpse of German university life. The focus was on courses of study from the areas of mathematics, informatics, the natural sciences, and technology (= "MINT" for short). But the schedule also included visits to companies, networking, and cultural offerings.

TWOFOLD SUCCESS IN TEACHER TRAINING

In the "Quality Offensive in Teacher Training" initiated by the Federal Ministry for Education and Research (BMBF), the University of Stuttgart has received good marks for its projects "Teacher Training at Professional Training Schools (LEBUS)" and "Teacher Training Plus". "Teacher Training Plus" is a joint project of the teacher training schools in the Stuttgart region and aims to build up a joint Professional School of Education. Partners in the project are the Universities of Stuttgart and Hohenheim, the Pedagogic Academy of Ludwigsburg, and others. The LEBUS project aims to attract more young persons to technical-pedagogical studies and to better prepare those who graduate from them for the increasing diversity found at vocational training schools, where teachers are frantically being sought for technical courses in electrical, metallic and structural engineering and informatics, while the numbers of graduates remain alarmingly low. To remedy, this, the new concept aims to start right at the school level.

NO-HANDS LANDINGS

Autopilots for small planes are not new. But now the University of Stuttgart's Institutes of Aircraft systems (ILS) and Flight Mechanics and Control (IFR), working with Diamond Aircraft Company, have shown that even automatic landing is feasible. Although pilots were present in the aircraft, they did not touch the controls. Instead, guidance was taken over by a fly-by-wire-system which operated the engines, moved the flaps and landing gear, and even braked automatically. The system is based on an AAA ("Triple A") platform technology from the ILS and the IFR's flight control algorithms. The system relies on satellite navigation and approaches landing fields with the help of radar and laser elevation measurements.

Verantwortung. **Chance.** Leidenschaft. Machen.
Zukunft. Veränderung. **Energie.** Netzwerk.
Bewegen. **Innovation.** Sicherheit. Team ›

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Promoting Talent, Mastering Challenges, Building Bridges

Science Brings the World Together by driving research and Innovation

Promoting scientific give-and-take on the transnational stage is a central task of the DAAD, the German Academic Exchange Service. But this goes beyond merely providing direct subsidies. Attractive formats which quickly draw interest to international cooperation must also be developed. The DAAD's President, Professor Margret Wintermantel explains research-relevant aspects of the DAAD's promotion policies and goes into current challenges.

In reaching its promotional decisions the DAAD assumes responsibility for the professional development of those who receive its stipendia. Simultaneously, the DAAD seeks to generate positive feedback for its research and innovation system. This involves attracting top-level personnel who will take over management functions in academia and industry as well as a broad-based sponsorship for young, talented persons who later often make decisive contributions to the research and innovation process.

PROMPT ENCOURAGEMENT OF INTERNATIONAL RESEARCH INTERESTS

In 2014 the DAAD used its many tools in helping individuals and projects by providing worldwide support for 29,800 doctoral candidates, scientists, and academic instructors. A major share of the projects involved the give-and-take of experience and joint scientific work, thus contributing directly to progress in research. Here the DAAD either provided individual subsidies, for example in its new post-doc program P.R.I.M.E. (Postdoctoral Researchers International Mobility Experience), or opened doors so that university-level institutions could put together their own tailor-made project promotion action packages. The “Strategic Partnerships and Topic Networks“ program is a good example of this.

It has been said that just because something's good doesn't mean it can't be better, and this begs the question of how to generate increased interest in an international outlook among doctoral students, with correspondingly more international networking by the scientific community. Our experience has shown that it is helpful for next-generation scientists of both sexes to acquire experience abroad even during the course of their studies. This reduces fear of the unknowns and prompts many of them to become “repeat offenders“. For example, the DAAD not only has long-established funding programs but also the “RISE Worldwide“ program, which gives Bachelor's Degree students the opportunity to take part in research projects of their choice during a practical training program abroad. This is an optimum combination for future researchers and often engenders the decisive motivation to continue on this path. The DAAD's wide range of funding tools makes it possible to support future scientists from the Bachelor's Degree to the post-doc phase by providing them with many types of support and encouragement on this path which is so important for their careers.

INTERNATIONAL RESEARCH IS GOOD FOR MORE THAN JUST RESEARCH

Clearly, international research cooperation must be guided first and foremost by the requirements of the respective research project; but the benefits go far beyond this: work carried out in an international environment, and daily contact with scientists from other nations open the way for an excellent understanding of their cultural backgrounds; it also helps train the ability to find optimum combinations for different ways of tackling things.

"The German way of doing science was once harshly criticized, and the USA looked like the "Promised Land"; but viewpoints today are much more nuanced."

Professor Margret Wintermantel, President of the DAAD

This intercultural training can have more sustained consequences for future careers than present research work, since such experiences apply to other activities as well and heighten the awareness of other cultures and perspectives in general. If the required openness is present, this aspect of work abroad not only becomes a source of great pleasure but also gives a sense of satisfaction that can help to get over the inevitable bumps in the road of research work. These aspects of international cooperation color the experiences of both Germans abroad and foreign next-generation scientists in Germany. The increased benefit for the individual and also for the whole of society becomes clearest in the case of regional crises, where the decisive factor is to keep lines of communication open. This is where the sciences provide a globally effective basis of communication. They are dedicated to rational and analytical thought and integrity in arguing points of view. The recipients and alumni of DAAD funding form a wide-ranging group whose competence we wish to use and must indeed use even more in future. This is where the networks of the future are already being established today.

NEXT-GENERATION RESEARCHERS ARE NEEDED THROUGHOUT THE INNOVATION SYSTEM

Statistics from the German Federal Research Ministry indicate that about 2.7% of those in each age group in Germany go on to doctoral studies. According to the organization for Economic Co-operation and Development (OECD), this puts Germany among the countries with an especially high quota of PhDs. On the face of it this is good news for a country like Germany, whose prosperity is largely due to research and innovation. However, a hotly debated question is whether this resource is being put to best use for the innovation system. Recent years have seen greatly increased investments in research, and excellent conditions have been established for profiling next-generation scientists, thus increasing Germany's attractiveness as a center of learning. On the other hand, however, the number of permanent professorships and research jobs in the academic sector to date has not grown accordingly, so that many highly motivated next-generation researchers find themselves forced with advancing age to switch to positions outside the academic arena which poorly match their profiles. How do next-generation scientists view this situation?" One good sensor of this consists of the GAIN Network (German Academic International Network), founded in 2003. GAIN is a collaborative initiative of the Alexander von Humboldt Foundation, the German Academic Exchange Service (DAAD), and the German Research Foundation. It promotes networking within the large group of German scientists and researchers working in North America, gives them a chance to discuss their interests, and keeps them informed about career perspectives in Germany. The annual GAIN Conference - last held towards the end of August 2015 in San Francisco - gives them an opportunity for an intensive give-and-take of views with persons in positions of authority from the German world of learning - an opportunity gladly and intensively seized upon by all concerned. The views of those who take part mirror developments here at home:

Whereas Germany's system of learning was the subject of much harsh criticism in the early days of the GAIN Initiative, and the USA appeared as the "Promised Land", opinions have become much more nuanced today. Both structurally and financially, needed improvements in working conditions have been recognized and carried out. All parties have come to realize that an exclusive

orientation to academic careers is unrealistic in view of the limited number of job opportunities and is in fact not even a desirable goal for those seeking an optimum design for the entire innovation system. Next-generation researchers are realizing more and more that they have acquired qualifications which can also be brought successfully to bear even beyond the bounds of their specific areas of expertise, provided that they plan their careers realistically and make prompt use of the overall spectrum of possible options. But these next-generation scientists are also making it clear that their return to Germany is not cut-and-dried, but that they will rather carefully compare their international options before making their decisions. Currently, Germany is recognized as a highly attractive seedbed of learning; this is a result not only of reforms in recent years but also of the country's excellent economic situation. That makes it incumbent upon us to purposefully continue the advance of our positive structural developments so as to remain internationally attractive even during economic downturns. This will also include the development of a welcoming, open culture.

WHO ARE IN FACT "THE BEST"?

If we look at the German innovation system as a whole, it becomes clear that not only "thinkers" but also "doers" are needed, and that constructive cooperation between them and the other stakeholders in the system is crucial for success. While it is true that professional competence in the respective research areas can clearly be quantified quite well with such key indicators as the "h-index", identifying and evaluating competence in the practical application of ideas is much more difficult - even though it is equally important if creative ideas are to gain a foothold in daily reality. This calls for a nuanced approach to evaluation. When we look at the large numbers of next-generation doctoral students, we can only hope and expect that the spectrum of job profiles will be far broader in appearance than one dictated by a fixation on a single key indicator. The complexity of selection criteria poses a major challenge for the many experts who draw up reports for the DAAD and other funding organizations, and they deserve not only our support but also our profound respect and deep gratitude. The difficulties of comparing and evaluating German candidates pale before those involved in processing applications from other countries. Last year, the DAAD provided help to persons from more than 180 countries. They came not only from highly developed industrial countries but also from emerging and developing countries, and in some cases directly from today's crisis areas. Frequently it is not clear at first glance whether differences in professional competence reflect different levels of activity or are simply the result of a limited educational system or even a different culture of learning in the person's respective homeland. On the other hand, successful applicants from countries with difficult political and/or economic situations display a competence in putting ideas into practice which is not to be expected from most of the candidates from industrially developed nations. The answer, therefore, is also to take the respective backgrounds into account in order to truly do justice to all. Thus the selection process involves major challenges, but also opportunities. For one thing, it helps us find the "thinkers" and help them in ways which would be out of the question in their homelands - what a great benefit for the world of learning! And for another, the "doers" can acquire the professional competence needed to solve current problems on location by applying modern and practically-oriented concepts and forms of technology. This


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“The refugee issue calls for us to find good compromises between the need to act quickly and the target of encouraging persons with promising potential to the best of our ability.“

Professor Margret Wintermantel

makes them important partners with Germany in their own countries and a key to the success of scientific, economic and political cooperation with these countries.

THE CHALLENGE OF THE REFUGEE “TSUNAMI“

Germany is currently being flooded as never before with refugees from regions of crisis in Africa and the Near East. This has confronted the German educational system with enormous challenges inasmuch as the potential of younger refugees cannot be assessed at face value, and they must make far-reaching professional decisions in a job and training market which is new to them. The issue here is to find good compromises between the need to act quickly and the target of encouraging persons with promising potential to the best of our ability. To the best of its ability, the DAAD will aid in this process, which also calls for comprehensive structural adjustments not only in preparations for study but also at the institutions of higher learning.

A WINDOW TO THE FUTURE

When I look at developments in the international system of higher learning and the challenges which result for the DAAD, the following aspects above all appear crucial to me: The market for higher learning has become global. New stakeholders are establishing themselves, the attractiveness of individual locations changes quickly according to the respective learning policies and economic situations, and there is a growing pool of excellent scientists and researchers who move with self-confidence and flexibility through the world. All over the world, the pressure for innovations is growing and with it the need to accelerate development steps from the stage of basic research to that of practical applications. Next-generation researchers need to be ready to work successfully in both areas - and not merely because the very limited array of jobs offered at institutions of higher learning may make it necessary to switch horses down the road. Areas of crisis are increasing in number in the world. This walls off an ever-larger pool of talent from access to the global market for academically trained professionals, meaning that valuable intellectual resources are lost. Most global problems today involve “crisis countries“ and can be solved only if sufficient expertise is available on location and problem-oriented professional collaboration is possible. For that reason it is imperative for us to create the preconditions for cooperation projects in which the areas of competence of the partners can develop and supplement each other in optimum fashion. On the whole, therefore, the need will become even more urgent in future to mediate between different worlds and to make use of synergies. This can only be done on the one hand by concrete collaboration between countries with different cultures and a variety of political, economic and technical environments, but also on the other hand by linking together basic research, applications, and practice. Making this contribution will continue in future to be a central task of the DAAD.

Roadway to a Global Society

The overriding goal of internationalization requires the efforts of many groups.

Society often refers to the immigration issue with the metaphor “the boat is full“. In the natural and human sciences, on the other hand, which have always been international in character, efforts are being made on all levels to increase quotas for foreign-born persons and to achieve a more international mix. This profits society as a whole.

“Truth doesn't wear any country's jersey.“ This sentence of journalist Jürgen Kaube, who writes on the sciences, appeared in an article in the “Humboldt Kosmos“ newspaper. It highlights the position occupied for centuries by the sciences. The Humboldtian ideal of education itself centers around the idea of the “citizen of the world“ who sees the entire globe as his home. Alexander von Humboldt himself is said to have stated that we should be suspicious of the world views of those who themselves have never seen the world.

The Come-Together-Day of the University of Stuttgart's Department of International Affairs brings together exchange students from abroad with University of Stuttgart students who plan to study outside Germany.

Now, 250 years later, academic organizations like the German Research Foundation, the Alexander von Humboldt Foundation, the German Academic Exchange Service (DAAD), the participating ministries of the federal and local governments, and the German University Rectors' Conference are trying to attract students and researchers from abroad, while the universities and private research organizations, along with world-market-oriented companies, exert themselves to be fit for competition on the international stage. The market seeks top-quality persons who not only have professional know-how but also think globally and are interculturally versed. Career pursuit today is almost unthinkable without having spent time abroad. Internationalization of the universities is also important for the social fabric as well: “During and especially in difficult times, the European academic culture contributes to peaceful co-existence. It is important that people from countries with other forms of government, other historic experiences and different religions and world views can study together and learn from one another,“ said Germany's Federal Minister of Research, Professor Johanna Wanka, at the International Bologna Ministers' Conference in the summer of 2015 in Jerewan

FIELDS OF WORK AT DIFFERENT STAGES OF DEVELOPMENT

From a practical point of view, the major target of internationalization is to harmonize different “construction sites“, each with its very own stage of development. For example, according to figures from the Federal Ministry for Education and Research (BMBF), some 140,000 Germans are now studying at foreign institutions of learning, three times as many as at the beginning of the Bologna Reform in 1999. Every year at the University of

Universities have always been a "melting pot" of cultures. In future, they are to be even more international in character.

Stuttgart, about 500 "outgo-ers" every year spend a semester abroad. "That is more than the average of our German technical universities, but there's still room for growth", is how Dr. Heiko Richter, Director of the University of Stuttgart's Department of International Affairs, comments on the numbers.
And the mobility of students in the other direction is even much higher: The number of foreign students in Germany has doubled in the last 20 years and now lies at more than 300,000. At the University of Stuttgart, about 5,600 foreign students from 125 countries were registered in the winter semester out of a total student body of 27,200; this is an above-average figure. The number of applicants with non-German passports is now massively on the rise, not least due to the waves of refugees from Syria and other areas of crisis. Getting a doctoral degree at the University of Stuttgart is also attractive for foreign students. "'German Engineering' is a real brand name, and is enhanced by good living conditions," says Richter.

BRAIN CIRCULATION AFTER GRADUATION

After graduation, however, the German universities have a hard struggle in the competition for the world's best graduates. Many foreigners return to their home countries, and those who stay tend more often to go into industry rather than to remain in the academic world. On the whole, about 4,000 more academically trained professionals have left Germany than have come into the country. There are many reasons for this - including under-financing of the German university system, limited-term work situations, a lack of perspectives for life partners, and gaps in child care.
Academically trained Germans doing research abroad are a special group in this "brain circulation". "Many of them would gladly return home, but precisely the best among them have very high expectations," observed Dr. Wolfgang Holtkamp, who is behind the University of Stuttgart's internationalization strategy as Senior Advisor for International Affairs in the President's team. Nevertheless, this group is very much in demand, for example within the German Academic International Network (GAIN). The reasons: those who return are not only highly qualified but also function as bridge-builders: "They bring international experience with them and are very well networked, but also know the German academic system from the inside," says Holtkamp. At the annual GAIN trade shows which alternate between Boston and San Francisco, or the European Career Fair (ECF) at the Massachusetts Institute of Technology in Boston, university directors strive personally to attract these minds to their universities. That includes Stuttgart's Rector, Professor Wolfram Ressel, who is frequently on hand at these events. The GAIN event is only one of many opportunities

Dr. Wolfgang Holtkamp at GAIN 2015, a contact and networking talent exchange for German researchers who work in the USA and Canada.

for further internationalization of the university. “What's important is to tune the components systematically to one another and build internationalization from the ground up,“ says Holtkamp. This begins right during studies: the goal is to enable every third graduate of basic study programs by 2018 to gather international experience and qualifications. Not only the exchange programs help in this but also more English-language courses in German study programs. To this end, plans are underway to increase to about 30 the number of long-established double-graduation programs in which students usually spend two semesters in Stuttgart and two at the partner school and graduate from both institutions. Double-Master's programs are currently being prepared at universities in Brazil, Spain, France, Canada and Poland. The first true “Joint Degree“, in the combined master-studies program in Machine Engineering and Mechanical Engineering was launched in 2014 together with the Georgia Institute of Technology in Atlanta (USA), one of the world's outstanding technical universities. In the area of research, it is planned on the one hand to make more intensive use of the potential for collaboration with European and non-European partners, as for instance in the EU's Horizon 2020 Research Program. To this end a project office was opened in July 2015, among other things to identify interesting cooperation possibilities and provide advisory services to the partners. And on the other hand, efforts will be made to bring about strategic unity in the international contacts of the University's 261 professors, 141 institutes, nearly countless departments, and 10 faculties - “Not an easy task within an independent academic community,“ says Holtkamp. But one that has many benefits, since it is precisely these already well-functioning international cooperation ventures which can help to anchor on the professional level a binational and multinational scientific network called SINUS (Strategic International Network University Stuttgart). “SINUS, if you will, is an alliance of international universities which make joint use of their locations. This applies not only to studies and instruction but also to common points of emphasis in research,“ is how Holtkamp explains it.

WELCOME@STUTTGART

A much more palpable project is one which aims to make it easier for foreign researchers to gain a footing in Germany and to concentrate on their research activities without bureaucratic hurdles: The University of Stuttgart Welcome Center. “We plan to create a single package under this one roof, tying together previously independent services of the University's institutes, Central Administration, and other partners,“ explains Department Head Heiko Richter. The initial point of access will include a personal contact person and a virtual platform with all relevant information, followed by seminars, and excursions. Support will begin with the planning of the stay and the formalities of entering the country, will include the time here in Stuttgart up to leaving, and will then flow directly into an intensive alumni contact program. This maintenance of relations with former guest

researchers is especially important for building up long-term research networks: “Many of our researcher alumni today are rectors or persons in comparable positions who still think back fondly to their time in Stuttgart. These persons are very open for cooperative ventures with the University of Stuttgart,“ is Richter's observation. One example of this is a Researcher Alumni Network supported by the Alexander von Humboldt

Continued on page 18

Chinese Researcher Alumni - and Enthusiasts for Stuttgart:

When laying the groundwork of the Researcher Alumni Network, Dr. Heike Richter, Director of the Department of International Affairs, and Dr. Jianqing Cai of the University of Stuttgart's Geodesy Institute interviewed 20 Chinese researchers who were guests in Stuttgart and have now taken over high-level positions in their home countries.


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One of them is **Professor Haiyn Hu**, who received his doctoral degree in Aerospace Engineering and studied as a guest under Professor Werner Schiehlen from 1992 to 1994 with a Humboldt stipendium at Mechanics Institute B, which today is the University of Stuttgart's Institute for Technical and Numeric Mechanics (ITM). Today, Hu is President of the Peking Institute of Technology and a member of the Chinese Academy of the Sciences. He thinks back fondly of Germany: “My experiences in Stuttgart made it possible for me to build up an excellent research group at the Nanjing University of Aeronautics and Astronautics.“ The biggest surprise for this scientist, who was born in 1956 in the huge city of Shanghai, was how pleasant life can be in a small German town: “My German courses at the Goethe Institute in Schwäbisch Hall were a wonderful experience which I wouldn't want to have missed for anything.“


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At the recommendation of his Germanophile doctoral advisor, **Professor Deren Li** did guest research in the 1980s at the Institute for Photogrammetry because its Director at that time, Professor Friedrich Ackermann, was “the most famous professor in the field of photogrammetry“. Professor Li ended by getting his doctoral degree in 1985 in Stuttgart. Today, Li is head of the Academic Committee of Wuhan University, a member of the Chinese Academy of the Sciences and the Chinese Academy of Engineers, and a member of the European-Asian International Academy of Sciences. “What especially impressed me in Germany were the carefully maintained academic atmosphere and attitude and the extraordinary ability to carry out research as a team“, reminisces Li, whose institution in China in the meantime now sends many more young Chinese to Germany for doctoral degrees as a result of his guest stay. *Ed*

As in the case of Vineetha aus India and Sonja aus Germany, the Linguistics Institute also brings different nationalities together with its “Tandem“ programs.

© Julia Schweizer

Interested crowds at the University of Stuttgart stand during the academic “Expo Estudiantes“ shows in Peru and Chile.

© Private

Foundation which invites Chinese Academics who have returned to their home countries after a stay in Stuttgart and have now risen professionally far up in the ranks. Ever since the 1980s, the University of Stuttgart has joined with Baden-Württemberg's Ministry of Science to maintain intensive contact with the “Middle Kingdom“: 220 Chinese guest researchers have been here over the course of the three decades. “The target of the University's China Program was the long-term furtherance of Chinese scientists, and this has produced excellent contacts. Today, inasmuch as China is a well-to-do country and can give something back, we are able to reap the harvest,“ says Richter. The network can generate impulses for new cooperative ventures in research. This collaboration should also and in particular benefit next-generation scientists, for example through the mutual mentoring of doctoral degrees or study papers and dissertations written abroad.

LIVING TOLERANCE

International diversity is not only good for learning but also benefits society in general: Wolfgang Holtkamp's own personal experience has helped to convince him of this. The curriculum devised by this expert in Literature Studies includes, among other things, a student online globalization project with students from India, the USA, South Africa, Russia, and Germany. “The participants not only study together but also spend their free time together during an excursion phase and stay in contact with each other after their stay abroad either personally or by means of social networks.“ It goes without saying that provocative works of research also result from these contacts. “The integration activity in these multicultural groups is enormous. While this may not lead directly to a global society, it prepares those who take part for life in a globalized (working) world,“ says Holtkamp. Persons who have studied or gotten doctoral degrees in this fashion are more tolerant later on. And catchphrases like “The boat ist full“ are squelched.

Andrea Mayer-Grenu

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The People is Us!

Professor Cathleen Kantner studies transnational public societies and Europe's democracy capabilities

Many problems, like refugee crises, disintegrating regimes, saving the Euro, or global warming cannot be solved by the affected states alone. On the other hand, attempts to circumvent the political institutions of nation-states may unbalance such democracies as have been organized in a national setting. So who, to use an old Greek word, are the "demos", the people whose voice legitimizes the decision-makers in the EU?

How do so-called "transnational" public societies on which the relational networks of even non-national stakeholders are based develop beyond national borders? Is there a "European Identity"? These are questions that drive Professor Cathleen Kantner, Director of the Department of International Relations and European Integration at the University of Stuttgart's Institute for Social Sciences, and also new Vice-Rector for Instruction and Continuing Education. Countless books and articles are piled up in her office. "Many people think that political science means reading newspapers and discussing them all day long," says Kantner with a laugh. "Our scientific field is politics. We try to reach a higher level of abstraction than we can do as citizens of the state who form opinions and possibly grumble about concrete politicians and certain political decisions." Cathleen Kantner carefully keeps her own political opinions separate from her academic research, and clearly states her qualifications when giving interviews about political topics like the last European election. Kantner's research focuses less on the daily politics that keep politicians, journalists and the man on the street in suspense every day. Born in Berlin but at home in Stuttgart since 2010, she also does not see herself as a political consultant - knowing full well that others in her profession do indeed set foot on this turf. Rather, she derives much more satisfaction from being able to analyze political developments over longer periods of time and draw conclusions from them for future political thought and action - with no need to have concerns about voter vagaries and commentaries in the daily papers in the back of her mind. As a social scientist, she delves intensively into the question of what transnational political communication means and how European society shapes itself in the public arena. Her interest in this topic awakened early: "I wanted to write my dissertation about institutional dynamics in the European Union and found that the public sphere plays an important role in them." She has been countered with the statement that a Europe-wide public arena is nonexistent. In return, Kantner insists that an EU-wide system of public communication exists - and therefore a European public arena as well. To make it more democratic, however, it would have to be systematically synergized more closely with the institutions of the Union.

THE ROLE OF COLLECTIVE IDENTITIES

To ground this hypothesis, she carried out large-scale, comparative analyses of media contents regarding nation-states. Her last research project, just concluded, consisted of a fascinating high-tech evaluation: e-Identity, an allied project of the University of Stuttgart's Institute for Social Sciences and the Institute for Natural Language Processing (IMS), as well as partners in Hildesheim and Potsdam. The project partners evaluated about 500,000 newspaper articles about wars and humanitarian military interventions from the years 1990 to 2012. To be able to investigate such a vast array of articles at all, the interdisciplinary


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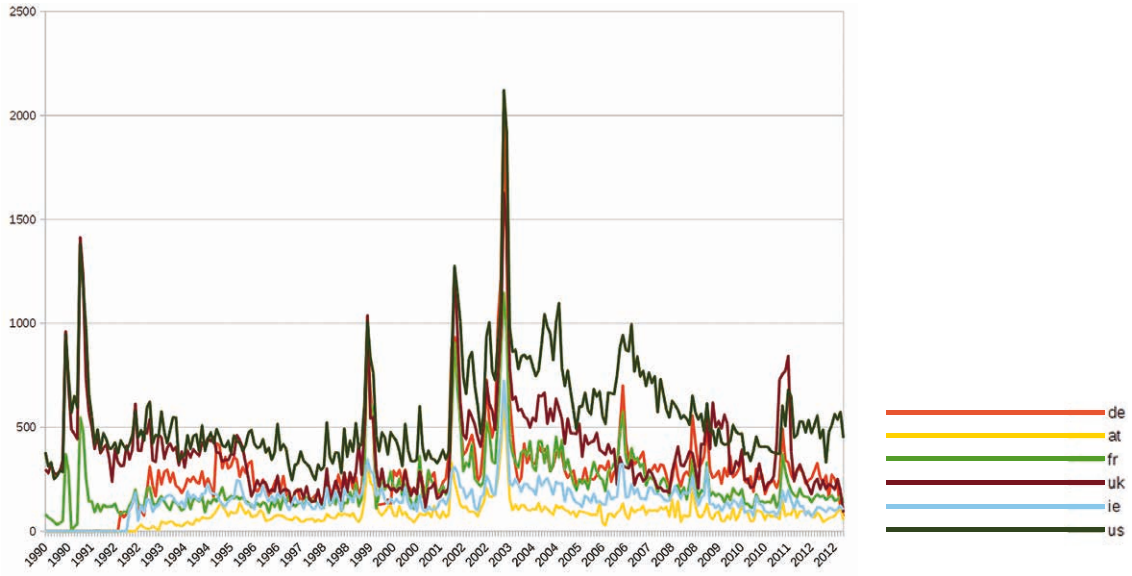
Niklas Luhmann
"Whatever we do today in Europe and whether we have been big-hearted or egotistical, courageous or timid in our dealings with one another in view of the great problems of our time, will be determined by the history which we look back on tomorrow and which we will recall with pride or shame." Professor Cathleen Kantner, social scientist



Project e-Identity: frequency of newspaper articles about humanitarian military intervention in six countries from 1990-2012. Figure: University of Stuttgart/IMS

team resorted to modern computerized linguistic methods which acted as a fine-meshed sieve, sorting texts in advance and very precisely collecting the articles of interest for the researchers. These were then subjected to detailed examination, interpreted, and evaluated.
The research team's aim was to clarify the role of multiple collective identities in the discussion about international conflicts. This may involve numerous interrelationships, especially since human beings in the rule belong to multiple groups. For example, many feel themselves defined by their respective nationality but simultaneously as Europeans too. “Precisely in the context of humanitarian intervention and in light of this multiplicity of relationships, we must ask ourselves which view of a good international order we represent and wish to work towards,“ says Professor Kantner. “What is the role we strive to fulfill as a group? What values are important to us?“ After the Wall fell, for example, Germans, not only had to re-orient themselves as a nation but also as Europeans and as a part of NATO.

In the same way, the members of the “Greens“ Party had to re-position themselves as a group regarding foreign policy issues at the time of the Balkan conflict in the 1990s. Many hypotheses exist concerning the phenomenon of collective identities. Many hazard the thought that national identities and a European identity are mutually exclusive: do people “forget“ their nation when becoming Europeans - or do they become blind for major international issues when they love their country? Do the cycles of attention in fact counteract each other in terms of national and European identities? Almost no one has successfully clarified such questions to date. “We're trying to do so now,“ says Kantner. And how are new identities formed? “Identities emerge in the interplay of looks to the future and the past,“ is her scientific explanation.

EXPLAINING SOCIETY TO ITSELF

But what does that mean for European Politics? For Kantner, the task of social scientists lies more in explaining society to itself, and she is skeptical of any effort to implement political solutions without consulting the public domain. Her view is backed by a basic democratic principle: “There is always more than one option for action, and the choice depends on what decisions people make. They themselves must assume responsibility for

this, as when they go to the voting booths. Experts cannot and should not try to relieve them of this.“ In Kantner's view, this bond between the citizen and the political arena must not be undermined by the experts, who tend all too easily to view themselves as “shortcuts“ in the complicated process of forming democratic opinions and wishes based on representative democratic processes. Allowing them to do so would be equivalent to disenfranchising the citizenry.

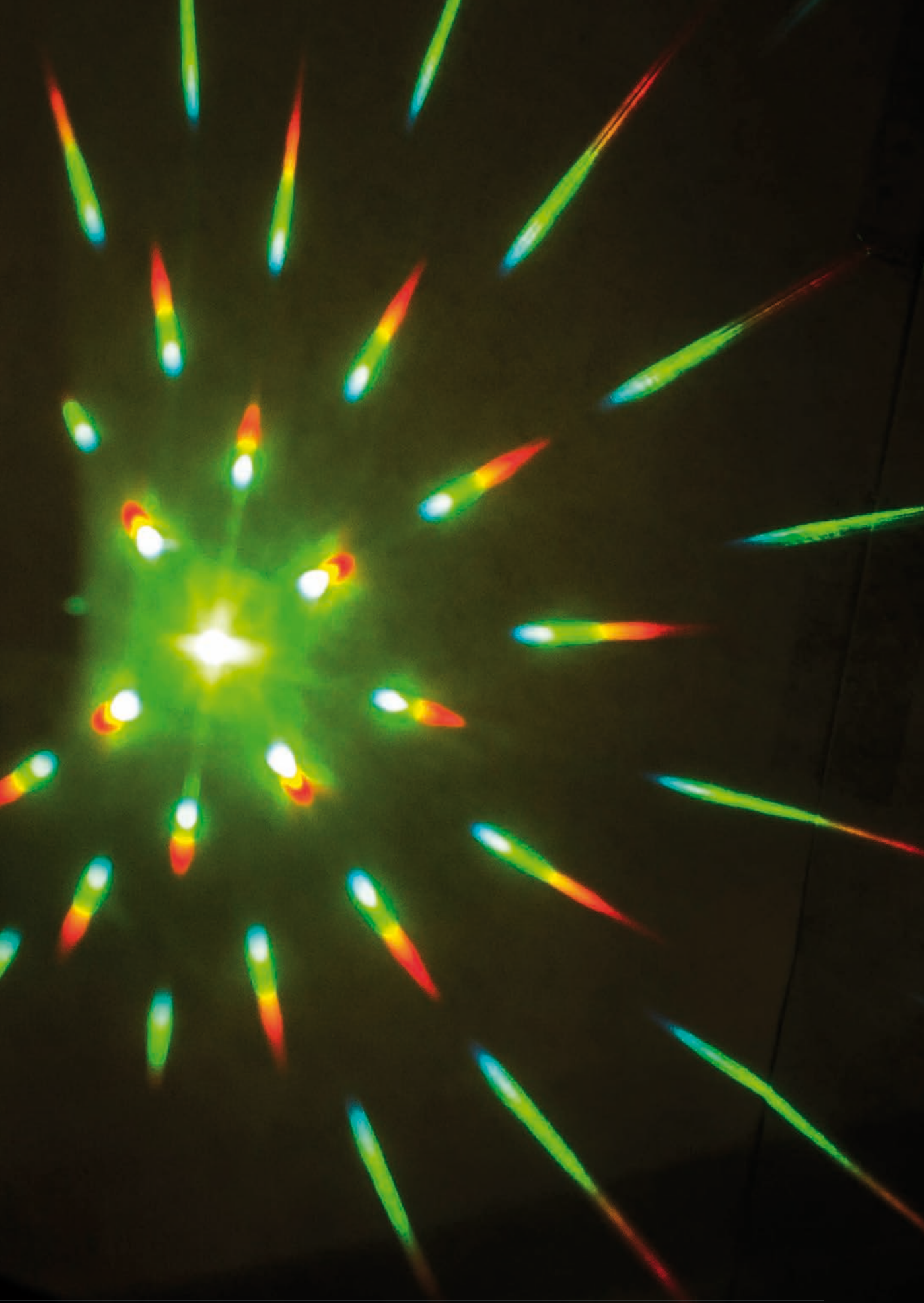
Kantner is convinced that there is indeed a transnational form of public communication about European topics. That in turn makes it important for this public form of communication to have a systematized, constitutionally guaranteed place in the political system of the EU. European identity in the classical sense of a normative history with a joint character can only emerge in the democratic political process: “Whatever we do today in Europe and whether we have been big-hearted or egotistical, courageous or timid in our dealings with one another in view of the great problems of our time, will be determined by the history which we look back on tomorrow and which we will recall with pride or shame,“ says Kantner. Modern societies are no longer based on traditions handed down from generation to generation or on religious convictions. Rather, societies today integrate themselves - as is also the case transnationally today in the EU - via the differences of opinion concerning the widest range of topics. “We must learn from ourselves what binds us and gives us direction,“ says Kantner. Over long periods of time, this will be the seedbed of a new, common history. One of the basic issues of democracy is to take care that power in fact remains with parliaments - whether national or European - meaning with the people. “The social groundwork for this has already been laid.“

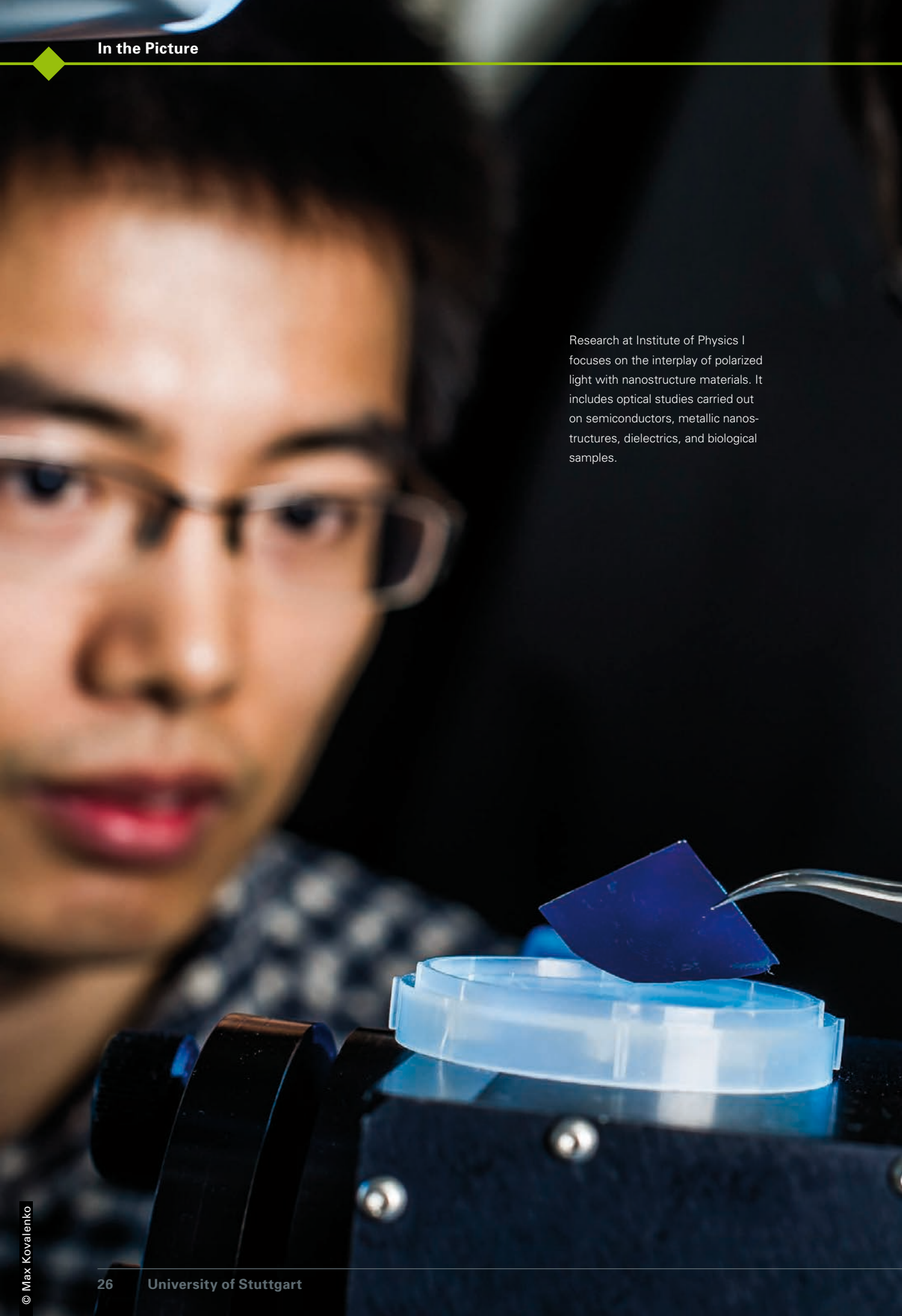
Jens Eber/amg

Let There Be Light

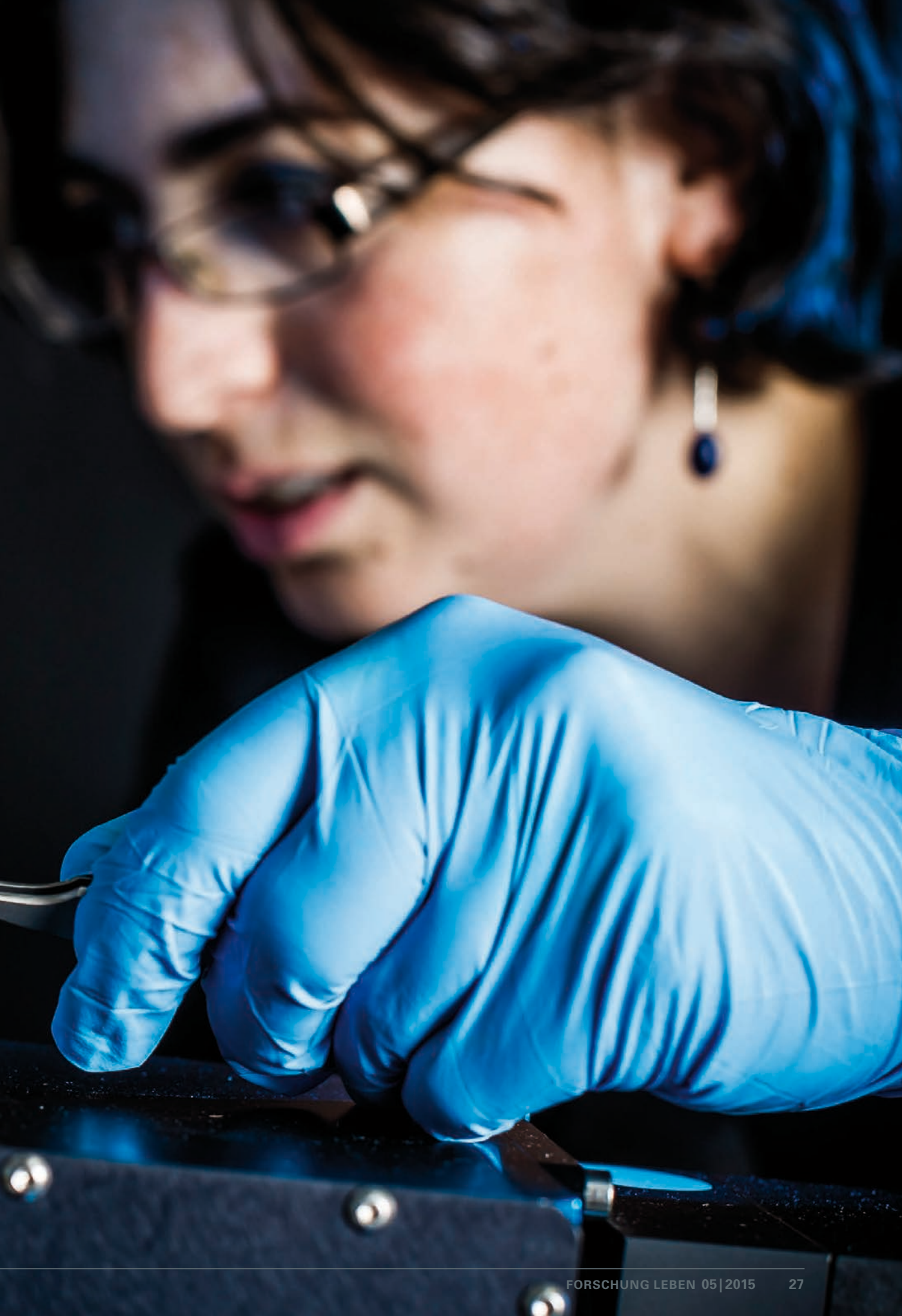
When the laboratory lights go out at the University of Stuttgart's Research Center for Photonic Engineering (SCoPE), a fascinating world of light begins to glow - a world in which new optical materials emerge, like ultra-thin metallic films, metallic nanoparticles, or new types of light sources and interferometers. And with SCoPE, the University of Stuttgart is also in a position of excellence in optics, photonics and optolelectronics when the topic is switching with light, ultra-speed nano-optics, atom-optics in wave conductors, semiconductor quantum points, or optimized nano-antennas.

Physicists and engineers from a total of 12 institutes have bundled their collaborative efforts in the SCoPE Program and are also intensifying their cooperation with the industrial world. The target is to close gaps in the chain that starts with basic photonic research and development and goes on to innovative developments and industrial applications. The group's research concentrates on modelling, simulation, the creation and characterization of structured photonic materials and surfaces, and on active optical structural elements and systems like new photonic chips. The range of research topics covers quantum structures and quantum optics, meta materials, plasmonics, and application-oriented task constellations in sub-wavelength optics and diffractive and active optics.
Thought is also being given to the next research generation: the associated interdisciplinary study program “Photonic Engineering“ helps to ensure that adequate numbers of optical technology professionals will be available for industry in particular.

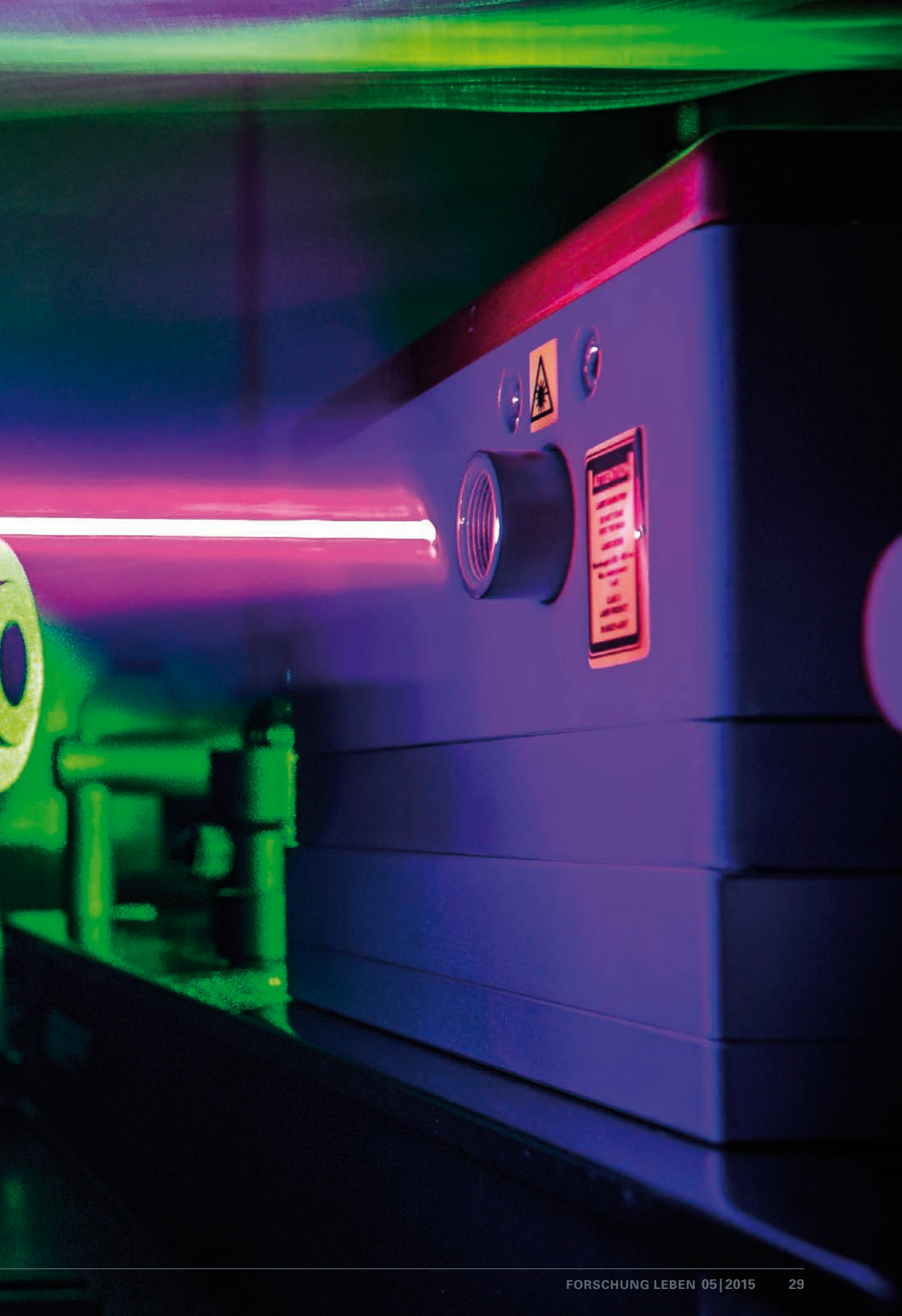


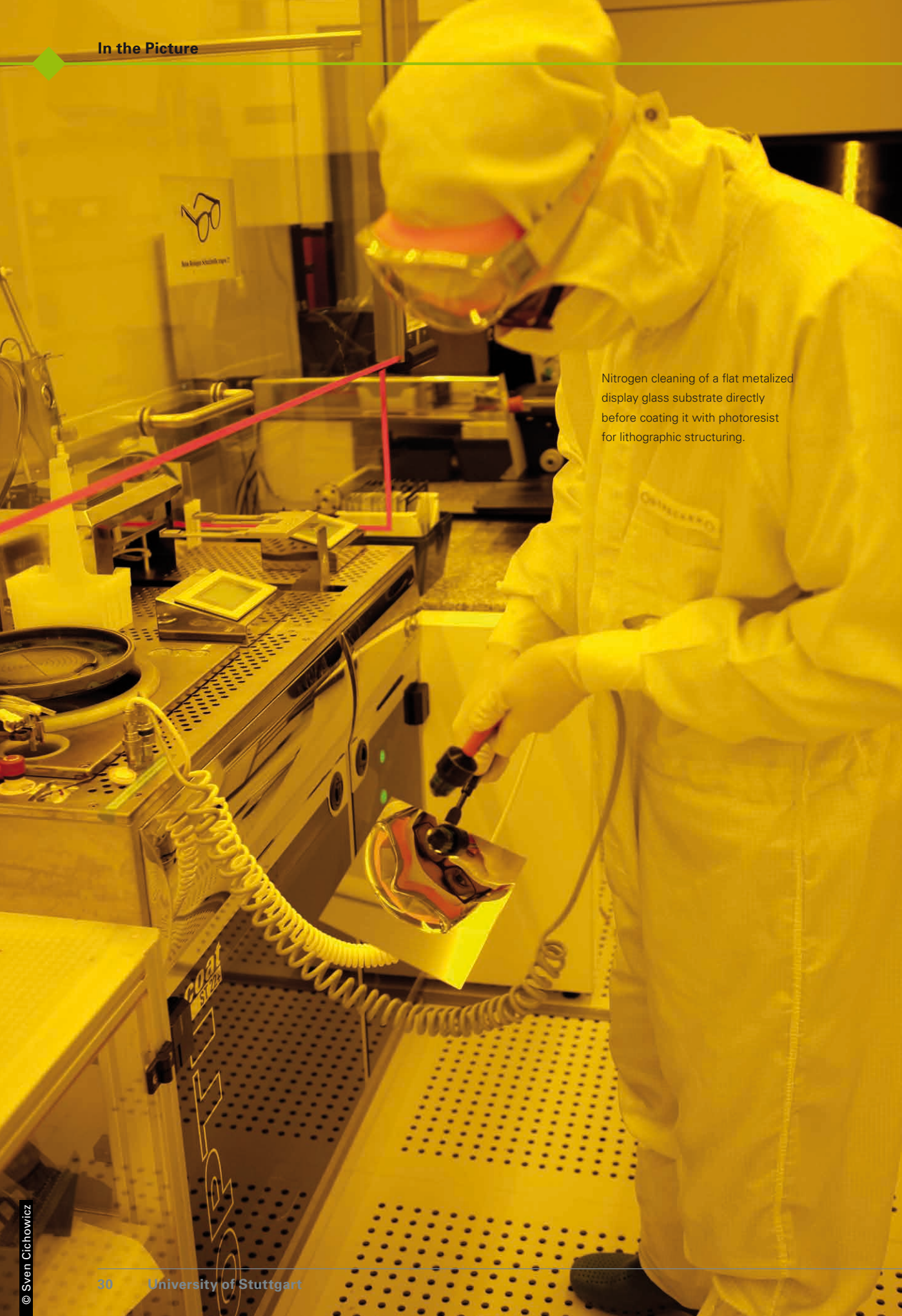


Research at Institute of Physics I focuses on the interplay of polarized light with nanostructure materials. It includes optical studies carried out on semiconductors, metallic nanostructures, dielectrics, and biological samples.

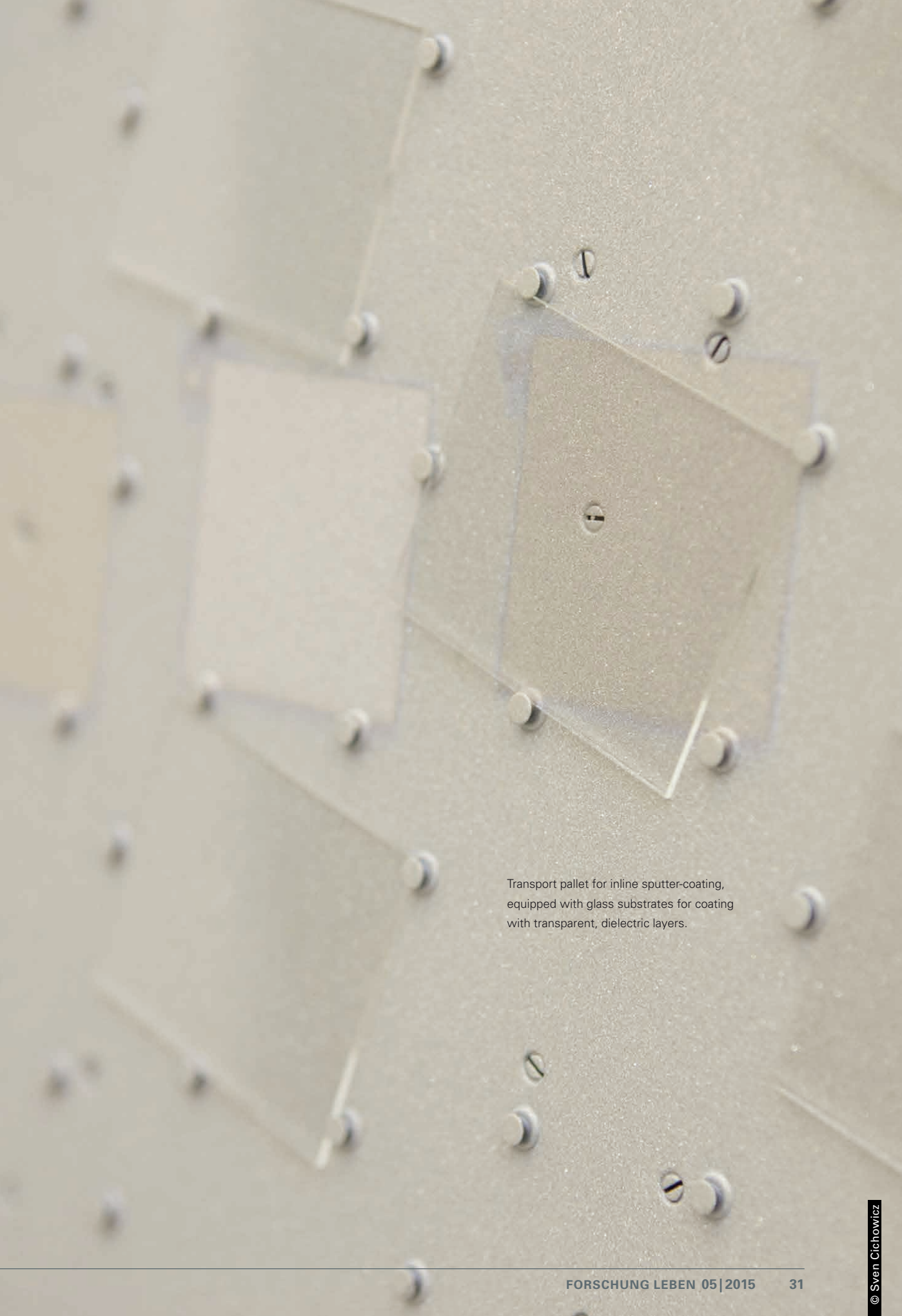


Semiconductor disk laser: semiconductor-based laser beam sources of high brilliance are still unavailable in the red and ultraviolet spectrum ranges. Research, development, and the optimization of these systems is carried here to the limit in the truest sense. Never-before-seen laser power from a prototype: 100 percent "Made at the University of Stuttgart".

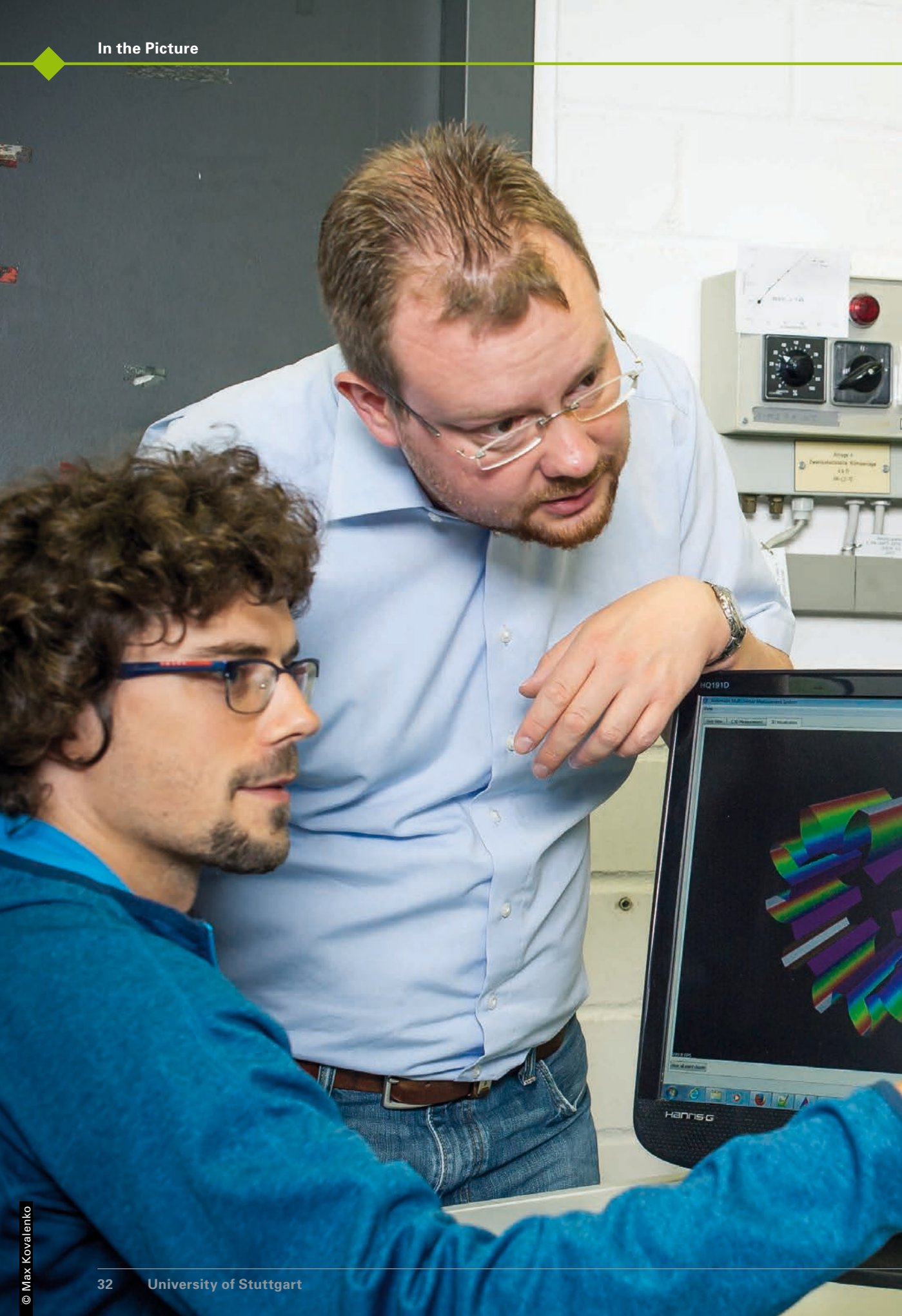




Nitrogen cleaning of a flat metalized display glass substrate directly before coating it with photoresist for lithographic structuring.

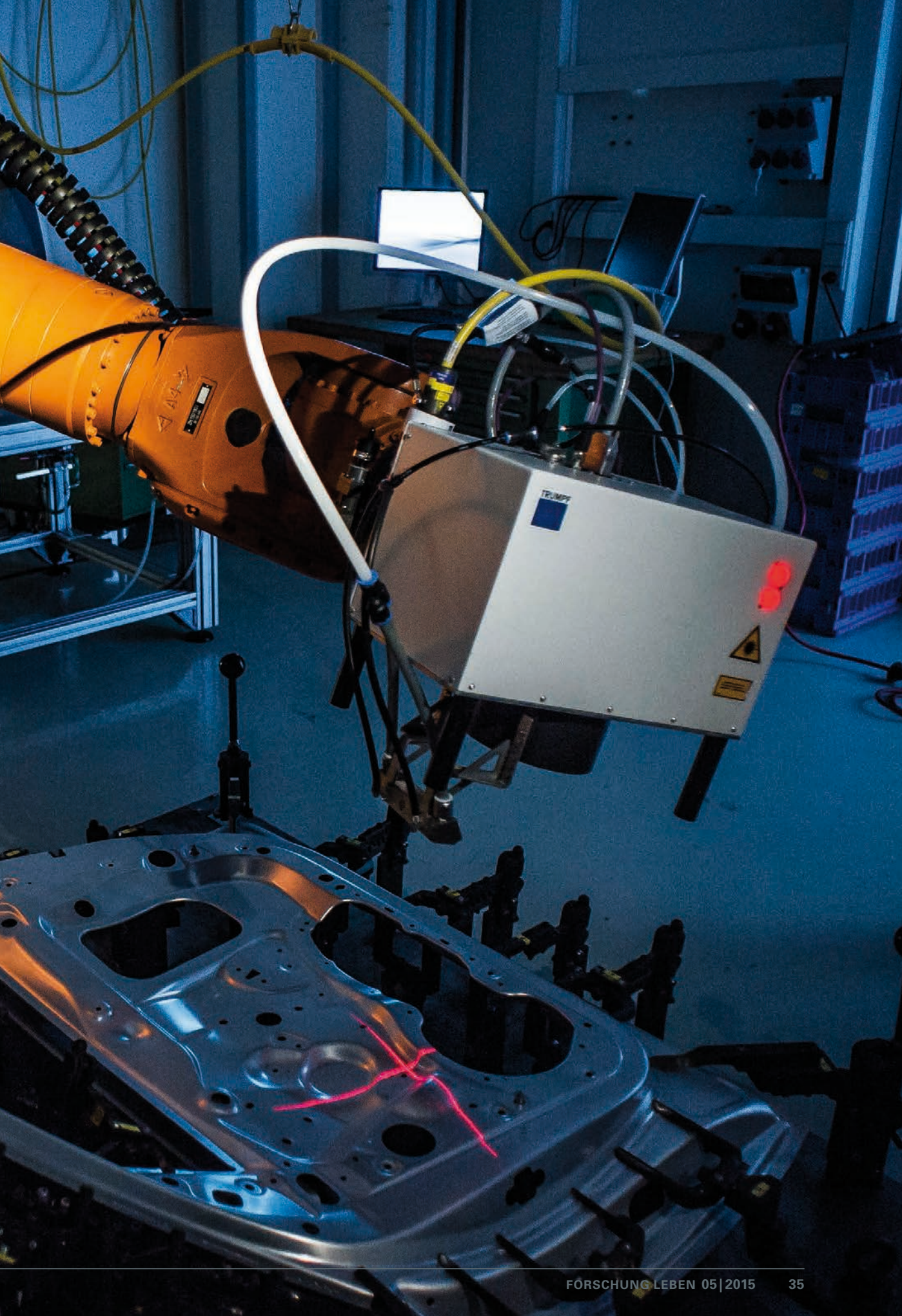


Transport pallet for inline sputter-coating, equipped with glass substrates for coating with transparent, dielectric layers.



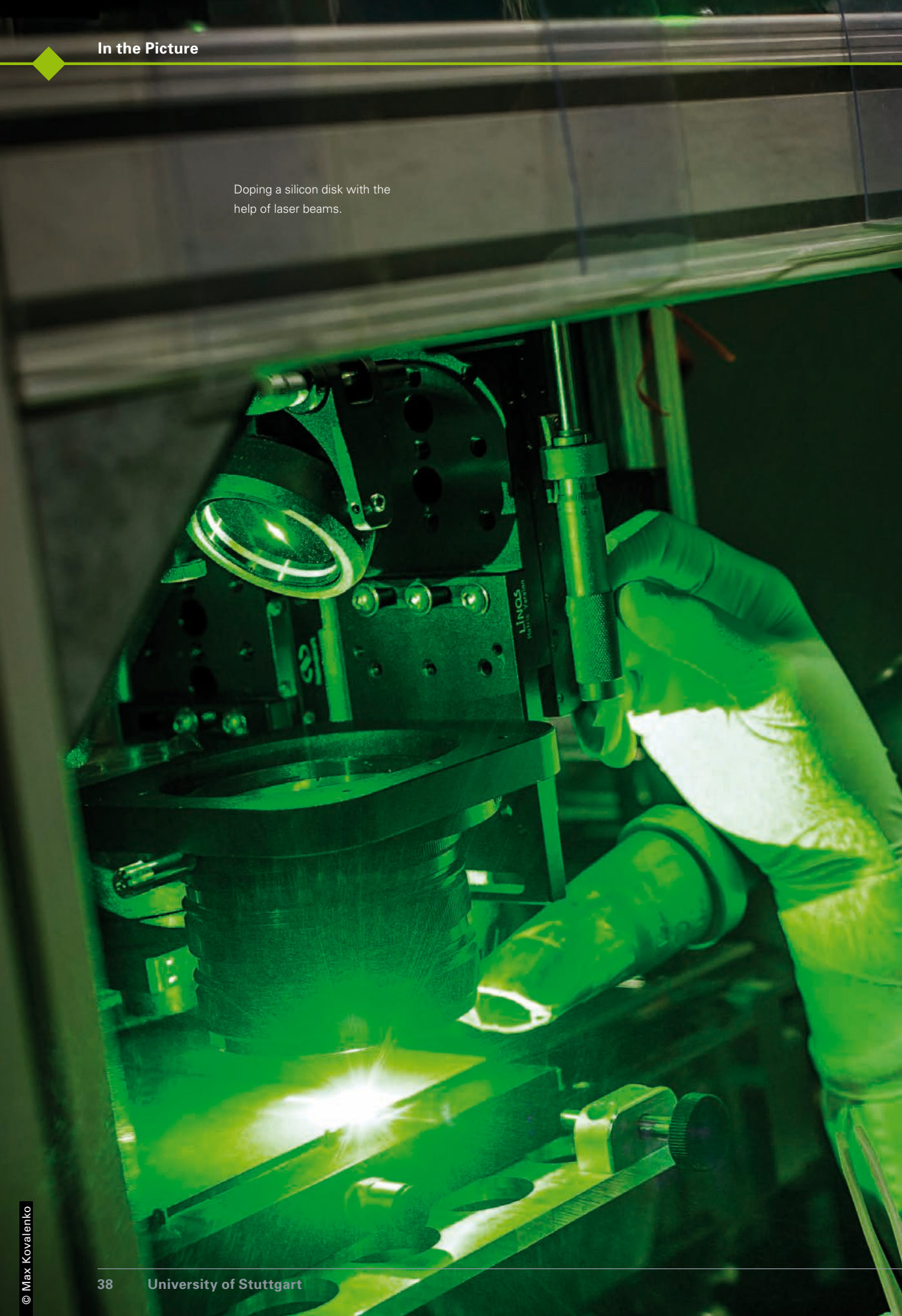
The Institute for Technical Optics (ITO) and the Institute for System Dynamics (ISYS) are doing joint research into flexible multisensor machines for the automatic inspection of technical objects. The design of the multi-axis actuator system permits precision movements which enable optimum tracing of selected surfaces by optical sensors. Assistance systems provide support in the automated planning, implementation and evaluation of the inspection as a whole.

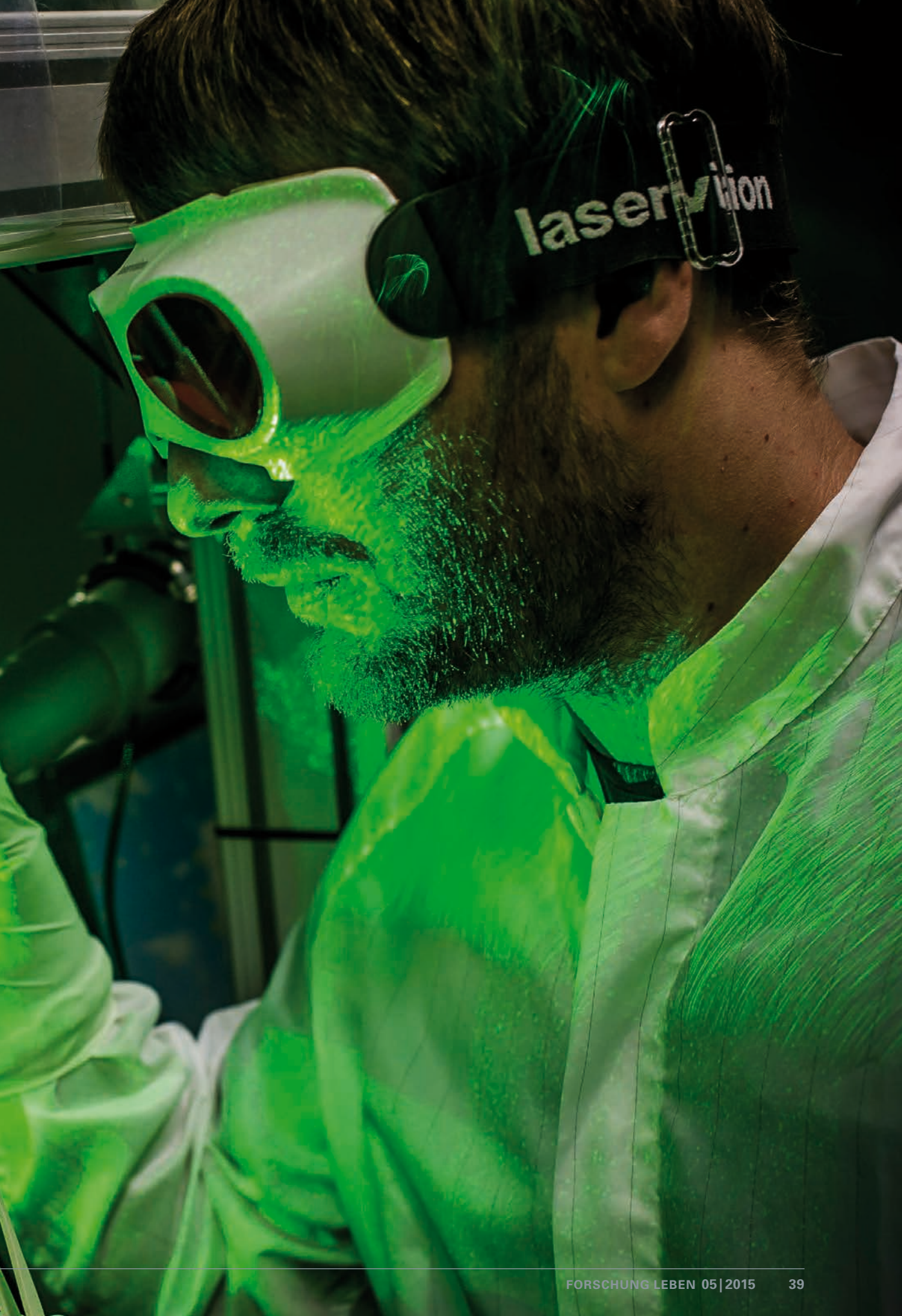
A modern laser application for lightweight automotive construction: a robot with scanner optics for remote laser welding of an aluminum automobile door.

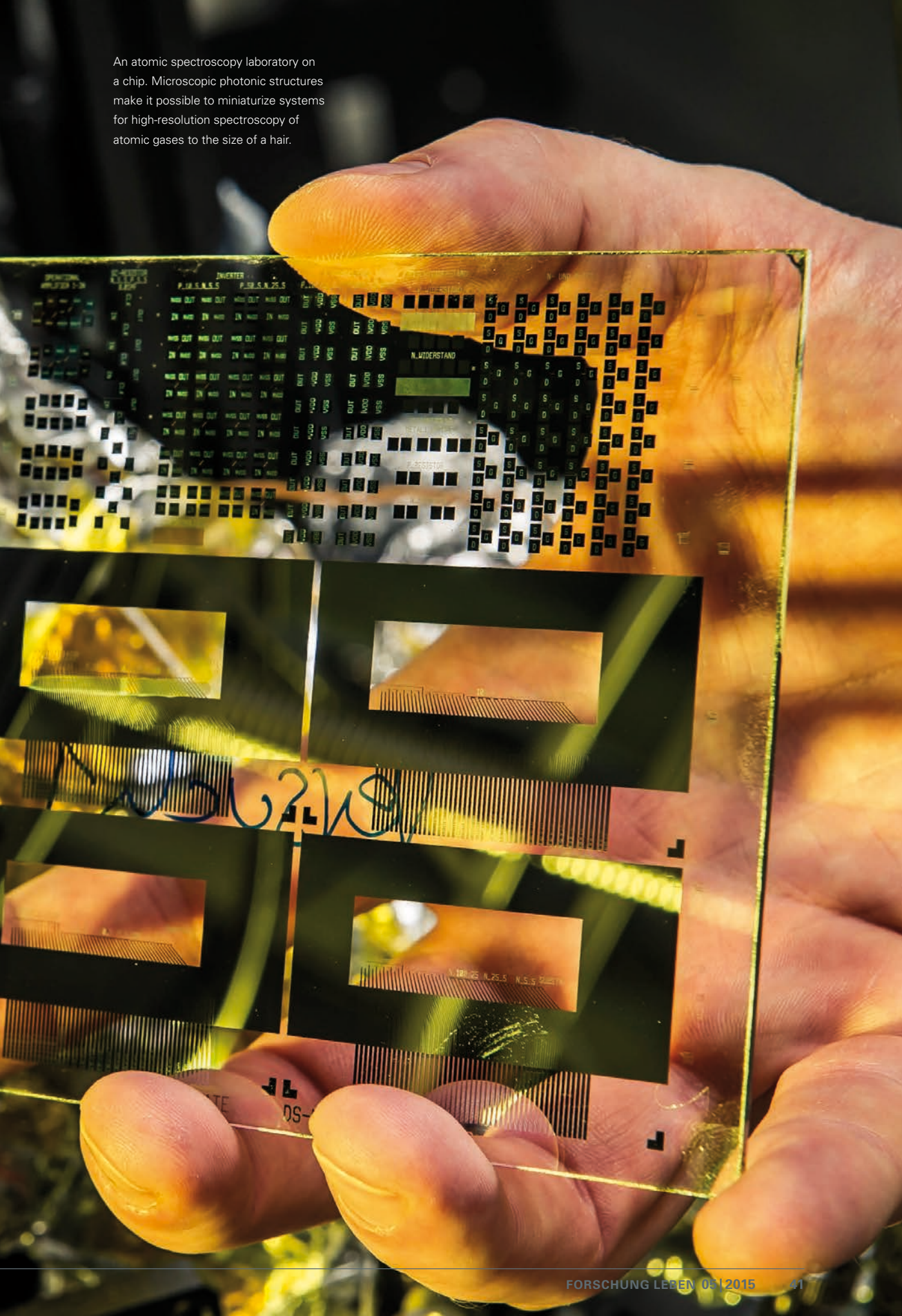


Partly processed solar cell after surface passivation with the help of a plasma technique.

Doping a silicon disk with the help of laser beams.



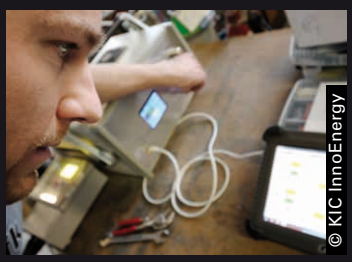

laser vision



An atomic spectroscopy laboratory on a chip. Microscopic photonic structures make it possible to miniaturize systems for high-resolution spectroscopy of atomic gases to the size of a hair.

The cell phone as microscope:
In the context of a Master's Degree thesis, a prototype optical lens attachment for cell phones was developed to permit microscopic camera images.


SONY

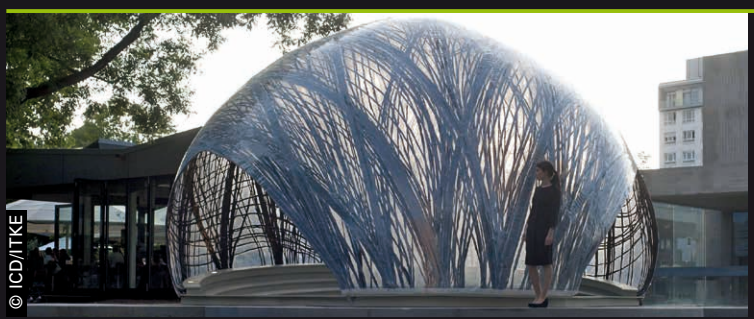


TAR RECOGNITION BY THE MINUTE

Biomass-generated energy is booming. In most cases, it involves energy conversion in the form of thermochemical conversion, meaning that wood pellets or wood chips are converted at high temperatures into gas which is then burned in motors to generate current and heat. In the process, however, the equipment operators must deal with the formation of tars which are deposited in pipes, catalytic converters, or at the end in the gas engines. In the worst case, this can lead to an equipment breakdown and expensive repairs. Now an innovative measurement system developed by Andreas Gredinger as part of his Doctoral Degree work at the University of Stuttgart's Institute of Combustion and Power Plant Technology (IFK) may offer a solution: the unit, called “DeMiTar“, performs fast, uncomplicated, quasi-continuous measurement of tar concentrations and pinpoints the optimum working point of the system. The KIC InnoEnergy Company assisted during development, and the unit is to appear on the market shortly.

VISUALIZATION TOOL FOR LONG-TERM MEDICAL STUDY

Medical studies gather a wide range of information about patients and their therapies - the more data, the more concrete is the knowledge gained. More complicated and subject to error, however, is their evaluation. The Stuttgart visualization expert Corinna Vehlow has developed a software for linking genetic information with any treatment success which may be achieved. Working at the University Clinic in Denver, she showed that her visual computer-aided method greatly simplifies the evaluation of large amounts of data. This has enabled American medical experts to derive important details concerning the successful therapy of cardiovascular diseases.



BUILD IT LIKE THE WATER SPIDER

A water spider spends nearly all its life under water and needs a stable air bubble for breathing. To preserve the air bubble, the spider builds a horizontal net and places the bubble under it. In another step it reinforces the bubble on the inside with fibers. The result is a stable construction which can withstand mechanical forces like flows of water. This lightweight construction method served as the inspiration for the University of Stuttgart's Research Pavilion 2014/15 of the Institutes for Computational Design (ICD) and for Building Structures and Structural Design (ITKE). But instead of a spider, a robot first created here a soft, air-pressurized film hull and then gave it rigidity by glueing carbon fibers to it step by step on the inside. The resulting extremely light-weight composite fiber shell structure demonstrates very high efficiency in its use of materials and simultaneously opens up new design horizons for architecture.

© University of Stuttgart/IFB

FIRST BATTERY-POWERED AIRPLANE ACROSS THE ALPS

A spectacular flight across the Swiss Alps, carried out by researchers at the University of Stuttgart's Institute of Aircraft Design (IFB), has shown what battery-powered airplanes can do in everyday flight - another important step in the direction of low-CO2, energy-efficient air travel. The electrically powered airplane, called "e-Genius", took off from Hahnweide Airport near Stuttgart and flew over the Alps to Italy. The high-tech battery-powered plane had to cover a distance of more than 320 kilometers in order to reach the Northern Italian town of "Calcinate del Pesce". In doing so, e-Genius reached a comfortably safe height of nearly 4,000 meters above the 3,000-meter peaks in central Switzerland.

DIESEL FUEL FROM WATER


© Sunfire GmbH

For the first time in the world, Dresden's sunfire company has successfully produced artificial diesel fuel on the basis of water, CO2 and environmentally-friendly electricity. And the University of Stuttgart's Department for Life Cycle Engineering (Gabi) drew up the environmental balance sheet, including a technical evaluation of the system and the fuel produced by it with overall regard to the potential environmental impact. During the study, the fuel, now called "Blue Crude", was compared with biogenetic and fossil fuels. The initial results showed that "Blue Crude" basically evinces a clear-cut potential for reducing CO2 in comparison to fossil fuels and can therefore bring major advantages to the environment. However, this potential can be exploited to the full only if renewable forms of energy are applied in its production.

LOGISTICS WITHOUT TACT TIMES AND ASSEMBLY LINES

Standard practice in the automotive industry for more than 100 years has been to keep to a tact time that precisely defines when, where and how each work step is carried out. The impact of this on production logistics is that materials too must be delivered to the assembly line in tact time. This system made it possible to produce goods efficiently, quickly, and above all at low cost. But it is too rigid for the requirements of today's ever-changing production schedules with more and more product variables and constantly diminishing production batches. The University of Stuttgart's Institute of Mechanical Handling and Logistics (IFT) is now working on solutions with more flexibility and adaptability at its ARENA2036 Research Campus. Among the centerpieces of the innovative logistic solutions developed at the IFT are intelligent, self-directing flow racks and new types of storage elements.

A World Under Construction

International Work Begins During Studies

What do students learn when they not only plan a children's home in South Africa but build it too? How can an instruction course be planned to mediate an understanding of different cultures? Working in intercultural teams, students at the University of Stuttgart's Faculty for Architecture and Urban Planning Stuttgart are processing projects all over the world. This requires a special approach which gradually becomes matter-of-course, as demonstrated by the very many initiatives of these next-generation scientists and engineers..

What language do international teams use for communication? What religious customs must be taken into account? Students from different disciplines experienced first-hand the challenges of intercultural collaboration in the "Urban Refugees Stuttgart" Project during the summer semester of 2015. The project brought together from different disciplines a total of 36 young Bachelor's and Master's Degree students with different nationalities - e.g. Egyptian, Turkish, US, South African, Columbian, and Chilean. Their assignment: to take up the current, burning issue of where and how to house refugees in Stuttgart and integrate them into the city's society. "It was very important to us that the projects be carried out in Stuttgart and have a clearly defined target", explains Marisol Rivas Velázquez, an academic assistant at the Urban Development Institute. "We were surprised at the high level of interest. But it also remained a challenge to carry out work in light of different cultures and societal backgrounds." The students worked on various sub-projects: an Internet contact page where volunteers and initiatives in refugee work could network, or an urban gardening project aimed at improving living conditions in a home for the disadvantaged with more attractive grounds and greenery. Another project brought refugees into contact with creative minds and residents. "We want to create an integrative urban place that helps people bond," says student Diane Stein. Concretely, her nine-member team from five different countries came up with idea of converting a discarded living container into a multifunctional space. "It is to serve as a platform for building bridges between refugees and residents." Her contacts with refugees prompted Stein to say: "We analyzed the conflicts and the opportunities and saw: there is an unbelievable potential in these people. There are artists and creative minds among them, young academic people, and highly motivated persons. But their surroundings make them succumb to lethargy. That was the seedbed of our idea." Stein noticed in herself how the project changed the team members:

An old container turns into a platform for refugees and residents.

Students make clay bricks for buildings in the low-income area of Ezbet Abu El-Shahat in Cairo.

"I grew up in an intercultural environment. But people become much more open here - if they aren't already." Most of the German team members, she says, either had a migrational background or spoke several languages and had traveled a good deal. "All of them are interested in international exchanges. The project is enriching because it forces people to expand their horizons," says Stein, and she gives an example: a workshop was planned in the middle of Ramadan, followed by a meal together. "It is important to show respect in such a case. One grows more aware of things that one would not have noticed previously."

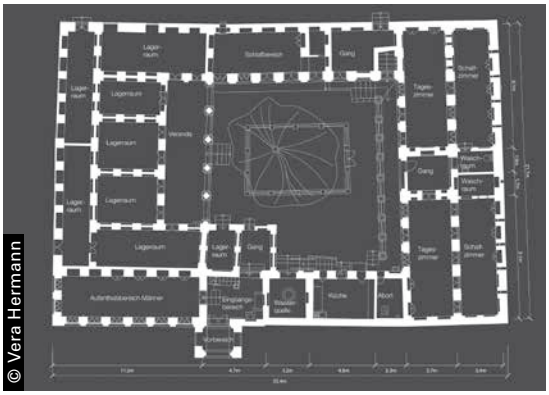
Her project co-worker Miriam Ceravolo confirms this. She came from Italy under the EU's Erasmus Program to spend a year in Stuttgart. "It was difficult at the beginning, not least due to the language," she says of her collaboration with Urban Refugees. "but it is also a really good opportunity to get to know the city of Stuttgart and the international community in the project." The team members were able to make the most of their diverse abilities in collaboration with the refugees while studying their situation professionally as next-generation researchers: "We are fortunate to have people among us who speak Arabic or Chinese," says Stein. "But English is our basis for communicating with each other."

RESIDENTIAL CULTURES IN COMPARISON

Another project turns its gaze to more distant - or even nonexistent - corners of the world: In Malawi it was customary to build rounded houses, but in Arabian countries often houses with wind-towers. But why? In order to let the students see concretely how variegated the world of housing is, architectural sociologists Professor Christine Hannemann and Dr. Gerd Kuhn came up with an unusual project assignment: to compare housing cultures in the form of a theoretical design proposal. "The assumption of this design proposal is that housing takes different forms in different cultures," is how the two researchers from the Institute of Housing and Design explain the idea. For this, the students were to study in each case one traditional and one modern construction type within a cultural region of their choice. Among other things, they analyzed life cycles, social units, climatic conditions, and religious influences. The last category above all played a decisive role in historic structural forms. Hannemann names the classical round huts in Malawi, for example: the belief there was that spirits lurk in corners. So houses were built without corners.

"Our basic thesis is: globalization will lead to the construction of comparable structures everywhere," says Hannemann. In place of the traditional narrow, shaded type of building and houses with cooling towers, Africa and Arabian countries will

Floor plan of one traditional and one modern home in Dubai. All rooms (top) in the building erected between 1924 and 1952 are grouped around a central courtyard. Air conduction and a summer and winter storey take endemic climatic features into account. The central room (bottom) of the building put up in 2011 is the living room; the modern concrete construction style and the large windows require air conditioning.



see glass palaces go up which require energy-intensive cooling systems. An example of this is shown in a paper presented by Vera Hermann, a student, on residential buildings in Dubai. The modern apartments are dominated by many private rooms and a European-American style of construction which would have been unusual in earlier times. The students had to display their intercultural competence even during the research phase: in order to get any information at all about the construction project in Dubai, Hermann got in contact directly with the architects who had planned it. And she presented herself in a resident's blog at one of the apartment buildings as a possible customer for an apartment. “You could call this 'participatory observation',“ says Hannemann to explain the research procedure. On the whole, the project members studied living cultures from Europe (Ukraine, the Netherlands, Germany's Swabia), Asia (Korea, Japan and China) and Arabia (the UAE). The comparisons yielded astonishing points of agreement, as the example of Shanghai shows: instead of the courtyard houses which were once traditional there, now apartment buildings like those in all other industrialized countries are going up. “This is where it gets interesting for the students,“ says Kuhn: “Will state-regulated Chinese residential construction still specify that the bedroom is to be on the south side for traditional reasons? That the dining and living rooms must be directly in the entry area?“ The flood of insights is enormous, he says: “Everyone is accustomed to live in his surroundings according to the customs of the moment. When outlining contrasts, the students realize how people live elsewhere,“ says Kuhn. “A historic comparison then shows: why do they do it differently? What were the possible shortcomings of the traditional structures? Why are social and climatic factors being left by the wayside?“ Area Director Hannemann's aim with the project is to “increase the intercultural competence of Stuttgart students and inspire them to investigate the topic from a socio-cultural and architectonic perspective.“ With that in mind, she has also invited a great many researchers of non-German origin to come to the faculty and give lectures about the residential cultures of their own countries. In line with this, the personnel - like the student body itself - is international in character. Hannemann's conviction: “The fruits must be harvested for the learning process.“

© Ezbet Projekt

In a recycling seminar during the Ezbet Project, students tested whether walls can be built from empty bottles

LEARNING WITH DIRTY HANDS

One of the participants in this lecture series is Dr. Manal El-Shahat. Born in Egypt, she now works as a scientific attaché at the University of Stuttgart's Urban Development Institute, where she is directing a major project, the Ezbet Project, in which students learn to work on a cross-border basis under the difficult conditions of a country going through radical change. The reason for Ezbet: nearly two thirds of Cairo's inhabitants live in so-called "informal areas" generally regarded in the country as slums. "The topic of development automatically includes development of these areas," says El-Shahat. That triggered the idea of building a community center in Cairo's Ezbet Abu Qarn Quarter at a location directly behind the oldest mosque in Africa. As a student at the Ain Shams University in Cairo, El-Shahat had already worked out a development concept for this area. Later, as an instructor and during her research during the initial project stages at the University of Stuttgart, she came upon Alshanyek Ya Balady (AYB), an NGO that works in Ezbet Abu Qarn, and entered into cooperation with it. The first 22 students went to Cairo on a 10-day excursion in October 2011. In full awareness of the politically unstable phase, the idea was to conduct meetings and get an on-site idea of the situation in order first to work out a theoretical design proposal for a community center. When the key players at AYB saw the design proposal, they purchased a piece of land on the spot and surprised the University of Stuttgart at the end of 2012 with the news that they did indeed want to build the center. AYB is actively involved in education, vocational training, and health care - and all of these activities can be housed in the new center.

In 2013, with the support of the German Academic Exchange Service, the University of Stuttgart and the Ain Shams University in Cairo jointly announced a student competition calling for design proposals for the center. 35 groups comprised of students from the architectural, urban planning and civil engineering departments of both universities submitted design proposals. For security reasons the jury met in Stuttgart. This was followed by ten workshops on construction of the model, selection of materials, and technology, at which 50% of the participants in each case were German and 50% Egyptian students - followed by more excursions to Cairo. "They needed to learn by getting their hands dirty and working with the local community," is how El-Shahat explains the purpose of the educational trips. The students worked with area residents and local craftsmen to test whether walls made of pressed clay or clay bricks and wastepaper as glue might be suitable. One recycling seminar even created a wall out of empty cola bottles. At the same time, the participants learned the meaning of work in one of Cairo's "informal areas"; for example, that a way must be found to occupy the many children who flock to the construction site. "It was important to show the local society what we were trying to do, so that they would accept us. And we had to experiment to find how we could build. The students had to think with us and talk to the community there about the possibilities," reports El-Shahat. The target of all partners today is to put up the Ezbet Community Center using simple techniques and on an environmentally friendly basis. The hope is that it will be the prototype for a sustained development process in one of Egypt's "informal areas".

A WORLDWIDE PLATFORM FOR EXCHANGING EXPERIENCES

In future, experiences and insights gained from the Ezbet Project and many other projects carried out

In the “Village of Hope“ near Cape Town, South Africa, students built houses for a relief organization as part of the Uqukala Project.

® Uqukala

by students from the University of Stuttgart will be gathered and archived on an Internet platform with the name: “e1nszue1ns - Architecture as Social Design“ (www.1zu1.design). The name stands partly for the scale of 1:1, since the projects are built not only as models but also in actual fact, as architect Leslie Koch explains. She is a technical assistant at the University of Stuttgart's Institute of Conception of Space and Principles of Design and is a project coordinator for the platform. And, she adds, “It is meant to express the equality of all participants,“ since one aim of the Internet platform is to network all those who work in one of the social construction projects in an uncomplicated way. It will transfer knowledge, work energy and resources among students, architects, organizations and donors.

A TOWN OF HOPE IN SOUTH AFRICA

One of the starting points for e1nszue1ns was Koch's own diploma thesis project in the year 2010: a new building with a regionally typical design was planned in South Africa for a relief organization which takes in homeless children. The major challenge: all of the work, from the design proposal to the finished structure, had to be finished within a semester. “We named the project “Uqukala“ meaning “Beginning“ in Xhosa, one of the languages of South Africa. “A great deal has come out of that beginning,“ says Koch in retrospect: students built three new buildings just in the “Village of Hope“ near Cape Town between 2010 and 2013. To be added to this are subsequent projects in other countries, like that of one female student who is putting up an elementary school in the city of Harare in Simbabwe with the help of Engineers without Borders and residents of the city. It would be easy, of course, to ask “Why should 20 persons go abroad to build something there?“ says Koch. “But we're not doing development work. It's a win-win situation because the students learn a great deal about the country, its life, and building techniques there - far away from tourists.“ It was namely a condition from the beginning to concentrate on the country and its architecture. “You also learn a great deal professionally when you stand at the construction site with the blueprint in your hands and suddenly understand the meaning of that hyphenated line that's always there,“ she says about her own experiences. Thus instruction courses about tools were part of the preparations so that the team could properly tackle jobs on the construction site together with the locals. “The projects are very dependent on individual persons,“ says Koch. “Every student who graduates takes his/her knowledge along when leaving the University.“ Should someone want to initiate a new project in Simbabwe five years lager, that later student could build on this former student's work via e1nszue1ns. For example, it would help to resolve questions quickly concerning the working language and any special religious issues.

Daniel Völpel

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Chinese Modern

Language Change in the Kingdom of the Middle Reich is Also Studied in Stuttgart

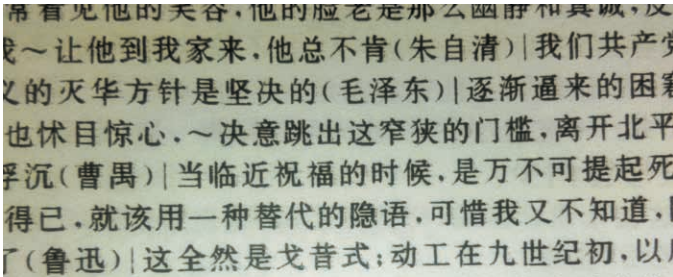
China has long since risen to the status of an economic and political world power, which also puts the spotlight more and more on the Chinese language, its structure and how to learn it. Many Chinese come to Germany to study. The University of Stuttgart meets both developments in a special way: The Institute of Linguistics and German Studies (ILG) offers the only Master's Degree program in Germany with a an emphasis on modern Chinese language studies.

Those who decide to learn Chinese, perhaps in order to work professionally in China or because of personal connections, find themselves confronted at first with a seemingly hopeless task: a mastery of at least 3,000 different characters is needed to get by in Chinese daily life, says Professor Daniel Hole, Director of the ILG. “Learning it requires an unbelievable effort.“ And the spoken word reveals problems of its own: four tone pitches in Mandarin and up to nine in Cantonese can give different meanings to a word that sounds the same to Europeans.

But linguists are not out first and foremost to learn a language. On the contrary: as scientists, they delve into its linguistic structure. “That does not necessarily mean speaking it too,“ says Qingfeng Schwaderer, a female Master's Degree student of Chinese origin and technical assistant at the ILG. “Our students need to understand how the Chinese language is structured so that they can carry out their own research into Chinese,“ explains Hole. For example, their work enables the latest research insights to become part of instruction materials. The overarching goal of theoretical linguistics is thus to describe the laws of a language as exactly as possible. In doing so, they lay the groundwork, for example, for automated translations..

NUR NUR NAM NUR EATS BEEF NUR

Hole gives an example from another southeastern Asian language: A Vietnamese sentence can use four words, all translated as “only“, their meaning being additive. That's somewhat like saying in German “'Only only Nam only eats beef only“' instead of saying correctly, “Only Nam eats beef“. The Linguist's job is to determine the function of all these seemingly superfluous words, since they probably don't all mean “only“. This happens, for example, upon a search for similar constructions in German, e.g. for emphasis on “doch“: “Actually, Paul wanted to eat 5 scoops of ice cream, but then he DID [DOCH] eat only one - and that was it.“ Once these structures have been identified, it becomes possible to compare them systematically with



Chinese particles, from: Hou, Xuechao (ed.): Dictionary of Function Words in Contemporary Chinese. Beijing Daxue Chubanshe, 1998.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Probing the structure of the Chinese language: linguists Professor Daniel Hole and Qingfeng Schwaderer

Vietnamese and other languages and define the functions of the different particles more precisely. Since past years have seen more and more Chinese coming to study in Stuttgart, the Institute has striven to build up a constant offering of Chinese and other Southeast Asian languages, says Hole. The university has made itself unique with its Master's Degree in "Linguistic Theory and Comparative Languages": "Here in Stuttgart, students find the only Master's Degree program for specializing in modern Chinese linguistics." According to Hole, this is because most sinological institutes have failed to cope with the focus changeover to contemporary Chinese. "They are still studying the 2,000-year-old "canonical" texts. While that is important, they fail to offer modern Chinese linguistics." Even most of the Chinese students, he says, have studied German or other foreign languages in their home country. "So their first encounter with modern Chinese linguistics is: here!"

WRITTEN CHARACTERS SURMOUNT DIALECT BORDERS

However, an attempt to derive rules for today's Chinese from the old texts would be like describing today's German with examples from Old High German, says linguist Hole. "In fact, you can compare the differences between dialects in China like those between Romanian and Portuguese." True, there is a "High Chinese", the Mandarin dialect of Peking disseminated via the media. "But the local dialects are very vital." This is where the many thousands of characters are advantageous: they are largely independent of dialects. "Such a written logographic language has advantages for keeping such a large country together, since dialects need not then be unified. One must realize that the Chinese have managed for more than 2,000 years to rule a national territory as large as Europe - with no difficulties in coping with the multitude of languages."

In order to study the Chinese spoken today, it's important for the Stuttgart researchers to analyze modern contemporary sources. "At any time, I can show the latest videos and get the latest articles, which was impossible in the past," reports Schwaderer about her seminar. For example, the students there are working on the function of articles or whether words are definite or indefinite, as it were, - as in German - or the question of whether to say "the house" or "a house". Chinese lacks both. "If I say, 'Sun shines,' it's clear which sun is meant," says Schwaderer.

Speaking as a scientist, she also reports that language in China, as here too, is changing with breathtaking speed due to the social media. "I hope to show the reality of language in current linguistic use." For example, students in a previous course complained of having to work with a 30-year-old book of grammar. More current literature was long unavailable. But now things

are changing. And Schwaderer finds words of encouragement for those who truly wish or need to learn Chinese: “Language is always an expression of the real world around us. And that world doesn't change all that much.“ Which is why even in languages there are things in common in spite of all the differences.

Daniel Völpel

International Chinese Conference

Qingfeng Schwaderer was one of the primary organizers of a Conference of the European Association of Chinese Linguistics in September 2015 at the University of Stuttgart's Institute of Linguistics. At this event, 70 experts in Chinese language research from 14 countries presented their findings to an international audience of professionals, of whom more than half came from China, Hong Kong, Japan, Canada, Singapore, Taiwan and the USA. The plenary session lectures were delivered by researchers from the Massachusetts Institute of Technology (MIT), the Humboldt University in Berlin, and the Chung Cheng University in Taiwan. “Stuttgart's Linguistics faculty fits seamlessly into these globalized structures,“ underscores Daniel Hole, Institute Director and Professor.

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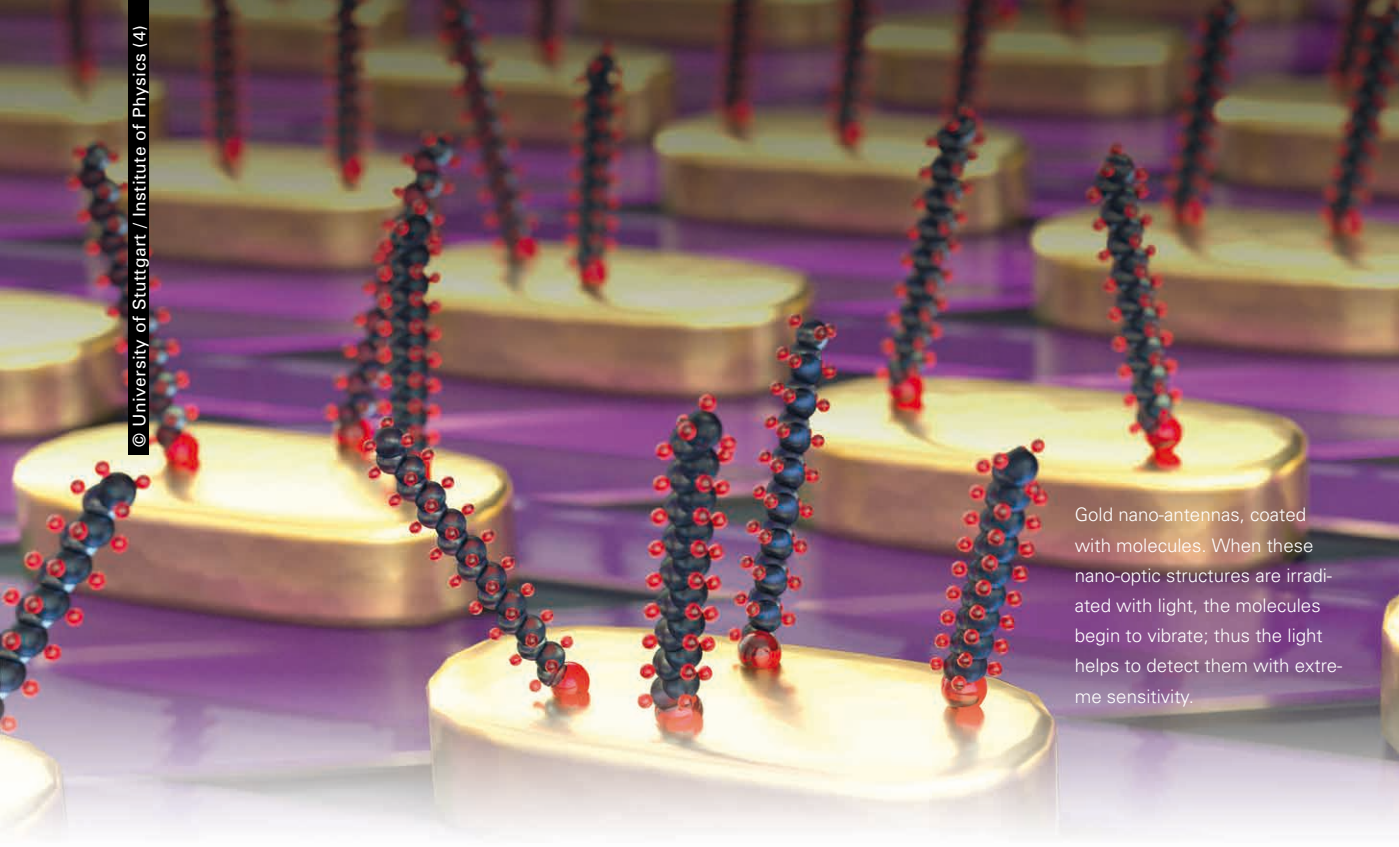


Gold nano-antennas, coated with molecules. When these nano-optic structures are irradiated with light, the molecules begin to vibrate; thus the light helps to detect them with extreme sensitivity.

A Quantum Jump With Quantum Sensors

Nano-optic components for high-precision measurement ensure international competitive leadership

The end of classical microelectronics is on the horizon. The transition to nanoelectronics will require new approaches based on quantum-physical effects. The Interdisciplinary Center for Applied Quantum Technology (ZAQuant) will be built in the next few years at the University of Stuttgart to bring physics, the engineering sciences, and industry together for joint research into new kinds of quantum sensors and their development into useable prototypes.

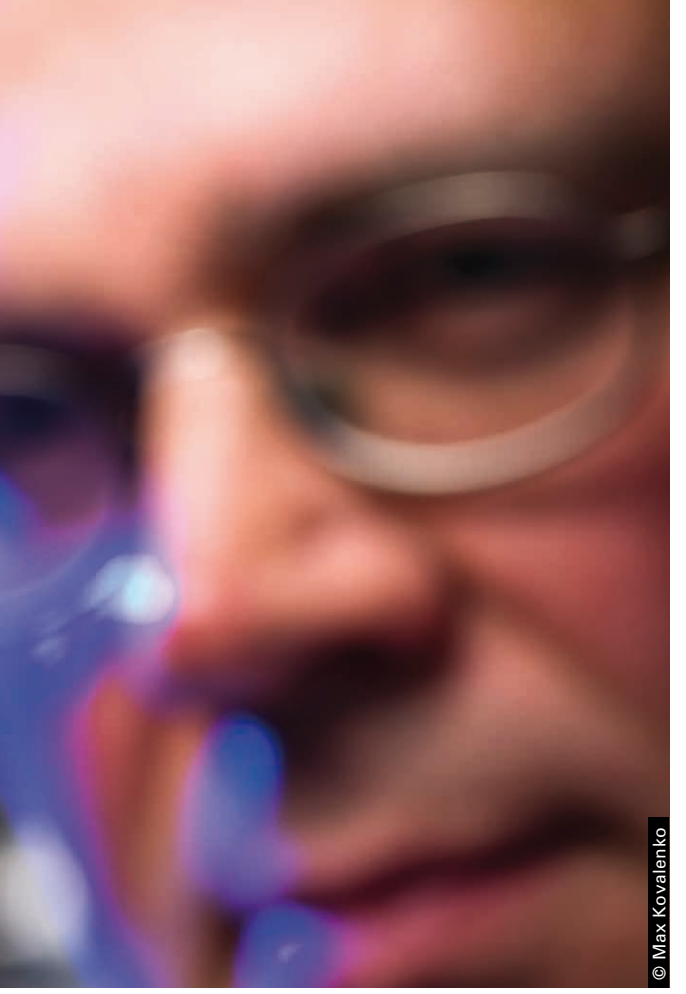
Back then, it looked more like a bent paper clip with a piece of germanium at each end than an electronic microprocessor component. But that first industrially useable transistor, presented publicly by Bell Lab scientists in 1947, launched the triumphant advance of the computer. Back then, the transistor easily filled the palm of a hand. Now, just 70 years later, transistors can be miniaturized and integrated so small that a smartwatch on the wrist contains a processor with roughly a billion transistors. Such a processor can stream videos in TV-quality on the smartwatch. When Professor Harald Gießen, Director of the University of Stuttgart's 4th Institute of Physics, talks about the up-and-coming changeover from microelectronics to quantum technology, he likes to use the last 70 years for comparison in order to make it clear where development stands today: "The Bell Lab transistor had a capacity of one bit: On-and-Off; that is possible today in the quantum world as well." However, this bit-analogon, called the "Qubit", comprises more, namely the two states of On-Off and all overlays of the two extremes. And there's still another difference: Generating this Qubit requires a complex laboratory setup which appears to be at least as bulky as the transistor of 1947. "The mid-1960s saw the first electronic switching circuits with perhaps ten or twenty transistors - we can't yet do that today with Qubits, not even in the laboratory," continues physicist Gießen. Not to mention the triumphant advent of the transistor radio or the first microchip-based processors in the 1970s. "So we're now standing

Strategic manipulation of the atomic structure of diamonds can turn them into sensors.

in quantum technology somewhere between 1947 and the 1960s.“ In other words: still almost at the beginning.

THE LIMITS OF CLASSICAL APPROACHES

But now is precisely the right time to set the course of research far into the future, believes Professor Jörg Schulze, head of the Institute for Semiconductor Engineering at the University of Stuttgart. “Recent decades saw, as it were, the semiconductor branch locked in a battle with quantum physics. But no matter how tiny the circuits - components are now being developed in industry with structural sizes under ten nanometers - all supposed, if you please, to function according to the rules of classical physics.“ But with very small dimensions the physical laws familiar to us in everyday life automatically cease to apply in all situations, and the rules of quantum physics take over: many physical dimensions can only have certain values, particles and waves are two sides of the same coin, and probabilities are the only thing that can be named about the occurrence of certain events. This has far-reaching consequences for the development and structure of computer logic or sensors which are based on quantum phenomena: consequences understood up to now only in their effects, but not truly in terms of their implementation in technically feasible components. “To realize the paradigm of the Internet of things - called “Industry 4.0“ in Germany - future calculation logic and sensors must use only one tenth to one one hundredth of the energy of today's systems, and it must be possible to manufacture them cheaply in numbers a factor of a million more than the production figures of today's systems,“ says engineering professor Schulze. All that will be hard to achieve with classical approaches. For that reason, now is the right time for the planned Center for Applied Quantum Technology (ZAQuant).
The scientists at the University of Stuttgart want to use it as a fulcrum for heaving quantum technology research in Germany onto a new plane in the practical application of quantum-physical effects. Professor Jörg Wrachtrup, a Leibniz Prize winner and Director of the University of Stuttgart's 3rd Institute of Physics, is at the helm of ZAQuant: “The target of our research there will be to develop new types of nanophotonic quantum sensors that permit major steps forward regarding sensitivity, specificity and energy efficiency in sensor technology.“ ZAQuant will require a new building, projected to cost 40 million Euros, on the University of Stuttgart's Vaihingen Campus. The University's Science Council has recommended funding the project, construction is expected to begin in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2017, and Wrachtrup thinks it will be wrapped up towards the end of 2019. “A new building is needed simply because ZAQuant requires precision laboratories that have to be specially insulated against interference from outside influences to permit precise measurement of quantum-physical effects,“ says physicist Wrachtrup. For example, the laboratories will require electromagnetic shielding which is at least a million times better than that of conventional laboratories. Much the same stringent requirements apply for insulation against ground vibrations and acoustic disturbances. “This will require corresponding structural measures even during the construction period,“ explains Wrachtrup.

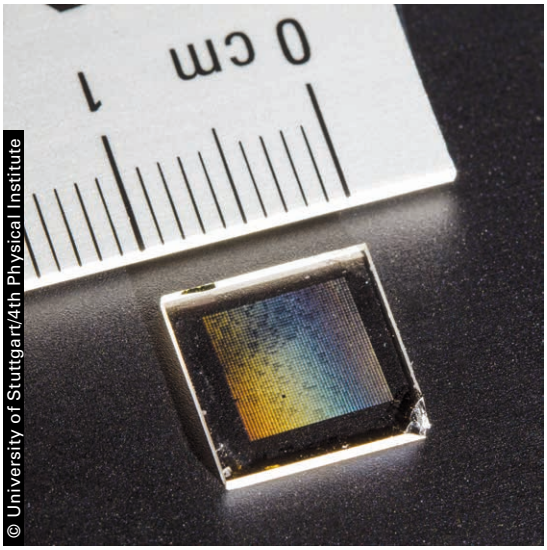
INTERNATIONAL BENCHMARKS

The decision to start ZAQuant is just one more in a series of worldwide research activities triggered in recent years by progress in quantum physics. Google is now setting up an institute in the USA for processing quantum information, and a task force is working on similar issues at IBM's research facilities at Yorktown Heights in the US state of New York. For its part, the same issues prompted Great Britain to put 250 million British pounds into a research program, and another large, 150-million-Euro quantum center is going up at the Technical University of Delft in the Netherlands. “What will set ZAQuant apart is that we will concentrate on the periphery and control of quantum sensors and their integration into components,“ says Wrachtrup. Research at the institute in Stuttgart will therefore run the gamut - from describing and measuring physical effects to studying the structure of prototypical components for use by potential users in experiments. “This constellation is the only one of its kind in the world,“ underscores Wrachtrup. The final result, for example, must be a new kind of component that can be integrated into an automobile or a computer.
Autonomous driving is one example of the future applications of quantum technology in sensorics. “While cars today navigate via GPS and position sensors,“ explains Wrachtrup, “autonomous vehicles will have to be able to navigate for an hour without GPS and with 50-centimeter precision - and today's position sensors can't do it.“ True, we already have more precise sensors, called “ring laser gyros“, like those used in airplanes. But these instruments are expensive and relatively bulky, because the laser beam needs a certain minimum area for sufficiently precise determination of position. “A quantum-physical gyro compass, on the other hand, is based on the elementary magnetic momentum of individual particles and thus should be open to extreme miniaturization,“ says physicist Wrachtrup. It would be several orders of magnitude more sensitive than conventional sensors, and since the properties of such “particle gyros“ are dependent only on physical, material constants, such quantum sensors would be more or less an “atomic standard“ - making their calibration superfluous.

THE LONG ROAD TO PROTOTYPES

But as Harald Gießen makes clear, tremendous exertions await scientists along the way to quantum

A broad antenna meshwork created from gold nano-antennas by two-photon laser lithography. These antennas are especially suited to extremely sensitive sensors.



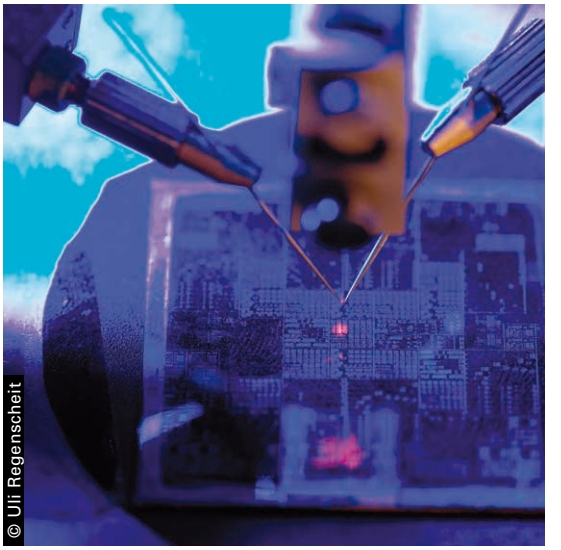
© University of Stuttgart/4th Physical Institute

Professor Jörg Schulze at the chamber lock of an IHT crystal breeder, where he is inserting a silicon wafer (left hand).

© Uli Regenscheit

sensorics. He gives an example: “Quantum systems for information processing and sensor technology can differ very widely in character; atoms, superconductor circuits, and diamonds are suitable for them - to name just a few examples. And even though the basic effect can be demonstrated with the aid of complex laboratory setups, we are still far from an easily useable or even miniaturized design which could still be integrated into the existing world of electronics.“ One requirement in relation to future chip integration, as he points out, would be the ability to combine atoms with metal surfaces, “and that was achieved with a single atom for the first time just recently in laboratories in Stuttgart and Singapore“. But as Gießen points out, no one has yet combined two or more atoms in such a way that their Qubits could communicate with each other over a certain distance. “Today we don't even know whether that would be more feasible with a mirror, a waveguide, a wire, or in a photonic crystal.“ But it is precisely the possibility of integrating quantum systems into electronic systems which would be an important step for the practical application of corresponding sensors. Therefore, as Jörg Schulze says, technical production conditions must always be taken into account during research into practical applications if true chip integration is to succeed. One example of such a restriction is the temperature range in which relevant production processes take place - quantum sensors too must survive them without damage. “What is also involved is a communicative conjunction between basic research in physics and the language of the engineering sciences,“ Schulze goes on. During his years of professional work in industry, he experienced how the different ways of expressing ideas in cross-disciplinary teams had people talking to each other without really understanding each other and thus without picking up on suggestions. “That's why I see our ZAQuant

After their production, structural elements are dimensionally measured at one of the IHT's opto-electronic measuring tables.



Institute as having a mediatory role, and I advocate joint teams made up, for example, of physicists and engineers." He could even envision this interdisciplinary quality during student training, as for instance when a quantum chemist or physicist would give part of a classroom lecture for engineers on semiconductor technology, or vice versa. It is planned to launch ZAQuant as soon as possible so that the first research projects can get started even during the building's construction phase. Once the building becomes available from 2020 on for regular operation, four large task forces and other project teams are to do research at ZAQuant. "There will be next-generation groups", says Jörg Wrachtrup, "and they will be supplemented by a fellows program especially for women." The new building is designed for about 70 staff members. "Basically, the scientists working at ZAQuant will remain members of their own faculties in order to ensure an intensive exchange of ideas," says Wrachtrup. Industry too will be in the boat at ZAQuant from the very beginning. "Our Advisory Board will include representatives of industry; we already have commitments from several persons for this," reports the physicist. ZAQuant will also benefit in its collaboration with industry from its close proximity to "technically oriented companies in the region". "Here we're thinking of companies of whatever size which show interest in the ideas pursued at ZAQuant. With this center we want to offer them a gathering place for joint projects."

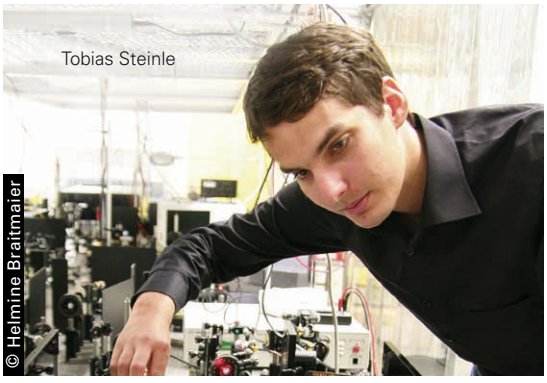
Michael Vogel

Face-to-Face with Nobel Prize Winners

Next-generation scientists from the University of Stuttgart meet the international research elite

For Theresia Richter and Tobias Steinle it was a great honor: they were among more than 650 selectees from 88 countries who attended the Nobel Prize Winners' Meeting last summer in Lindau. Richter, a chemistry student, and Steinle, a physicist, had the chance to test the mettle of 65 Nobel Prize winners in many discussions and events.

"It was an unbelievably pleasant and enriching happening," is Theresia Richter's high praise. She is currently getting her Doctor's Degree at the University of Stuttgart's Institute for Anorganic Chemistry. The 27-year-old was astonished when she was approached on the very first evening by Elizabeth Blackburn, an Australian-US-American molecular biologist and Nobel Prize Winner for Medicine in 2009. The invisible wall separating the elite and the next-generation researchers at most professional conferences seemed to disappear in Lindau. "Everybody talks to everybody," reports Richter. the doctoral candidate was deeply impressed by the life stories of all the Nobel Prize winners, often full of uncertainty and difficulties, and their many charismatic personalities. "I learned to be pluckier, less doubtful about whether things would go well, and just give it a try," says this chemist. Her research tool back in Stuttgart is an autoclave, a sort of pressure cooker. Among other things, it boils metals like zinc at temperatures up to 600° C and a pressure of 3,000 bars in an ammonia atmosphere. The target of this so-called "ammonothermal synthesis" is to produce the pure semiconductor crystals required, for example, in LEDs, lasers and transistors. "Up to now, zinc nitride still is not found as a monocrystal whose component parts form a unified, homogeneous crystal grid", explains Richter, who comes from Germany's Nürtingen. This is needed to eliminate disturbances in the electrical behavior of semiconductors. In industrial production the nitride crystals are usually grown on substrates like silicon disks, whereas this is unnecessary in ammonothermal synthesis. "The different properties of nitride and silicon often cause defects in the nitride crystalline structure", says Richter. She has still not succeeded in manufacturing zinc nitride while working for her doctorate with Professor Rainer Niewa, but at least many intermediate products. "That allows us to determine the conditions under which pure, high-quality zinc nitride and other new types of semiconductor materials emerge," says Richter.



© Lindau Nobel Laureate Meeting

The Nobel Prize Winners' Meeting in Lindau brings the international research elite - here Elizabeth Blackburn, the Australian-American Nobel Prize winner for Medicine - face to face with the (likewise international) next generation of scientists.

"IT BROADENED MY HORIZON"

Tobias Steinle, a doctoral student under Professor Harald Gießen, is also full of praise for the meeting in Lindau. "It greatly widened my disciplinary point of view, and I saw how many interesting issues remain topical in science," says the 25-year-old student. For example, Steinle was fascinated by the new discoveries in astronomy. Although this hobby was originally his motivation for studying physics, his passion today is the laser. Steinle is developing a microscope that not only shows outlines and contours in the classical sense but can also be used to study the chemical composition of samples. "For example, we can analyze the proportion of proteins or fats in a cell and where they are located within the cell," says the doctoral student. The basis for this is "stimulated Raman Dispersion": when a laser beam in the infrared range strikes the naturally vibrating molecules of a sample, a small portion of the light scattered there has a different wavelength than the stimulating laser. Since every molecule vibrates in its own characteristic way, it can be clearly identified by its "optical fingerprint". Switching on a second laser now accelerates the measurement a thousandfold. Previously, when researchers wanted to know where a substance is located in the cell, they had to couple it with fluorescence molecules and stimulate them with a laser to emit light. "Would I see the same thing without this modification? I don't know," is how Steinle describes a drawback of the conventional method and adds, "Our technique reduces intervention in the system to a minimum." The optical setup of the microscope is currently still so complex that Steinle the physicist says "a Doctor's Degree" would be required to operate it. He wants to simplify the microscope without limiting its performance capabilities. He has also modified the infrared laser so that its wavelength can be changed. "The greater the wavelength range we cover, the more different materials we can analyze," says Steinle. As a physicist, he deliberately sought out prize winners in medicine and biology at the Nobel Prize Winner's meeting. "I wanted to know what they try to measure in biological samples so that I can structure the microscope setup in this direction," says Steinle. "When you talk about science, it makes no different what country you're from - in contrast to hot-button political topics like climate change," says Steinle.

Helmine Braitmaier

Solar Energy - Getting It Right

Research collaboration improves energy use in the southern hemisphere

Das Potenzial der Solarenergie ist in vielen sonnenverwöhnten Regionen noch bei Weitem nicht ausgeschöpft. Doch nicht alles macht im Hinblick auf Energiebilanz und Wirtschaftlichkeit auch Sinn. Wissenschaftler und Wissenschaftlerinnen der Universität Stuttgart werden daher in den kommenden Jahren das Potenzial von Solarkraftwerken im chilenischen Bergbau untersuchen. Für die Energieversorgung südafrikanischer Städte haben sie dies bereits getan.

The potential of solar energy in many sunbathed regions is far from being fully exploited. On the other hand, not every idea makes sense regarding the energy balance sheet and economic feasibility. That will give researchers at the University of Stuttgart reason enough in the coming years to study the potential of solar power plants for Chile's mining industry, as they have already done regarding the energy supply of South African cities. Chile's Atacama Desert is one of the driest regions on earth, but also a treasure trove for the mining industry: gold, silver, copper and lithium are found here abundantly. For example, four of the world's largest copper mines are in Chile. “Desert“ means sunshine, and “mining industry“ means an insatiable appetite for energy - a situation practically predestined for solar power plants. But producing energy with the sun's help has its pitfalls: will energy be needed around the clock, or is there only a limited, temporary need at night? That would require energy storage devices, which could drive investment costs sky-high. Dr. Ludger Eltrop, Head of the Department of Systems Analysis and Renewable Energies at the University of Stuttgart's Institute of Energy Economics and Rational Use of Energy (IER), sums it up: “We plan to work on location with Chile's Solar Energy Research Center (SERC) and the mining industry to see which mining industry applications really make sense for solar power plants and how big they have to be.“ Eltrop directs the project, called “Solar Mining Chile“, which is jointly financed by Germany and Chile. It is scheduled to last for three years, and was

The aim is to use solar power plants like this Spanish platform more intensively in Chile and elsewhere.

kicked off in the summer of 2015. The project partners are aiming to create a roadmap for more intensive use of solar energy in the Chilean mining industry and to foster a give-and-take of know-how in the analysis of life cycles of innovative technologies. Both the IER and SERC already have considerable experience in this area of research. Moreover, solar power plants are already being put to initial use in the Chilean mining industry, although Eltrop says they fall woefully short of their full potential there. “For example,“ he says, “a Danish-Chilean consortium is using

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Dr. Ludger Eltrop studies the potential of solar energy for the mining industry in Chile's Atacama Desert.

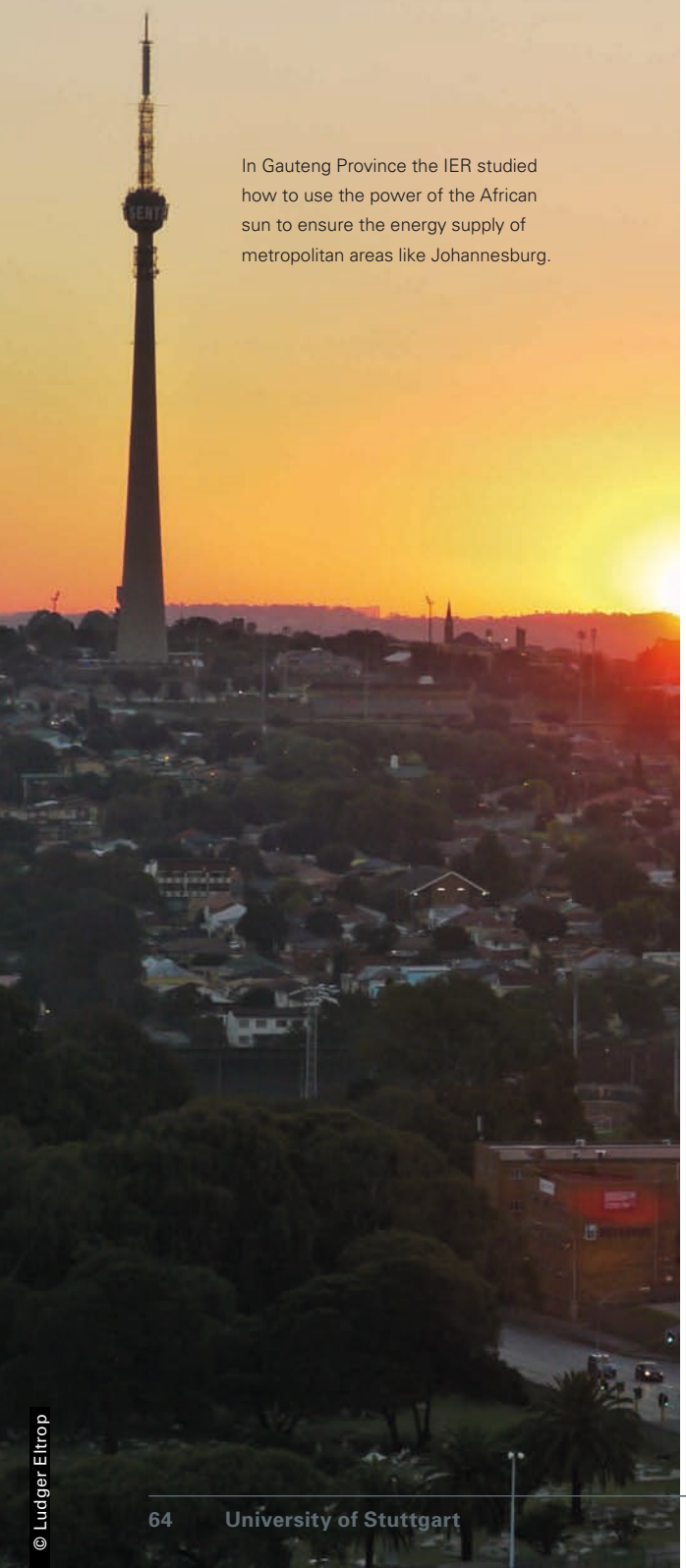
a thermic solar plant in one of the copper mines; it powers the electrolysis baths which derive pure copper with solar heat.“ The baths must remain permanently at 50 degrees centigrade. We think many other areas in the mining industry could use renewable energy“, says the scientist. One candidate for this would be the mining of lithium, the principal material in modern rechargeable batteries. “The basic principle involves pumping water from salt lakes into artificially created ponds. The water evaporates there, leaving behind lithium and other salts“, says Eltrop. “The pumping has been done up to now with mains current, but the ideal would be a solar power plant, perhaps with a properly designed energy storage device.“ How this - expensive - storage device could best be dimensioned and what effect the involvement of solar energy might have is what the project partners want to find out, using life cycle analysis and other means.

“BIG SOLUTIONS“ AREN'T ALWAYS BEST

As Eltrop says, “Answering such questions means analyzing all processes used in deriving such materials in order to find the areas best suited for energy from a solar power plant.“ Other questions here are where solar collector stations and solar thermal power plants would make the most sense. With solar thermal power plants, sunlight is bundled by means of mirrors or lenses and transferred in a heat-carrying medium to a power plant. Basic to the analysis in each case is then a comparison with the energy now supplied by fossil fuels in the mining industry. “The results might tell us that a complete changeover to solar current in the energy supply of a mine doesn't make sense, but very much so for individual areas - for a smelter, for example, or in electrolysis.“ The IER can fall back here on sophisticated models which the team can take as a basis for development. The roadmap created from the results will then be transferrable with relative ease to possible solar mining activities in other dry areas - e.g. in South Africa or Australia.

ENERGY FOR MEGACITIES

Solar mining is not the IER's first research project regarding the use of solar energy in the southern hemisphere. From 2008 to 2013, Eltrop and his team were already studying the use of solar power plants to supply current to megacities as part of the “Future Megacities“ program, funded by the Federal Ministry for Education and Research, and in the IER “EnerKey“ Project. These projects brought together as participants not only various German research and study organizations and the city of Stuttgart but also local partners in South Africa. Both projects were focused on increasing the reliability of a supply of energy for Gauteng Province, which includes not only Johannesburg



In Gauteng Province the IER studied how to use the power of the African sun to ensure the energy supply of metropolitan areas like Johannesburg.

© Ludger Eltrop

but also two other major cities. The project participants had to find the right concept against a backdrop of pronounced income differences in the region and the need for sustainably satisfying the energy requirements of less-privileged households as well. A further question was whether it makes sense to supply energy supply by operating solar power plants in especially sunny areas of South Africa.

USING THE SOUTH AFRICAN SUN

"One of our doctoral students succeeded in showing in a dissertation that this "distant resources" approach would pay off both with regard to the energy balance sheet and in terms of economic feasibility", explains Eltrop. Both the South African and the Chilean research project are proof of the fact that solar energy offers great, still untapped potential. "The results are making it easier for us to transfer such issues to other countries", says Eltrop, "because we can better recognize how our investigations can be adapted to the basic conditions in those countries."

Michael Vogel

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Two oranges - not 20 - mean good luck: doctoral candidate Julia Sachs (front row, 4th from left) with her department team at Bosch during the Chinese New Year's Celebration in Singapore.

From Ditzingen to Singapore

Julia Sachs researches hybrid energy systems for far-away regions

1.3 billion human beings worldwide live without access to electrical current. In particular, isolated and rural areas in African countries south of the Sahara and in South and East Asia are cut off from the power grid. A promising, cheap and quick solution here could be combinations of conventional diesel generators, renewable forms of energy, and batteries.

Diesel-powered generators are often the only source of electric current for persons living in thinly populated or hard-to-reach areas like islands, rural areas, or the highlands of Nepal. Widening the power grid would not be economically feasible for those operating it. “On the other hand, electricity from generators is relatively expensive due to rising diesel fuel prices,“ says Julia Sachs of the Institute for System Dynamics, but adds, “We can lower costs by adding and integrating renewable energies like solar power. Sachs is working on such so-called “hybrid“ energy systems as part of her doctoral thesis. This requires female engineer Sachs, who hails from the peaceful town of Ditzingen, to commute more than 10,000 kilometers every three months between Stuttgart and the teeming metropolis of Singapore, with its millions. But then it's only a “hop, skip and jump“ from her workplace at Bosch there to Southeast Asian regions lying far from the power grid. Working with a computer, Sachs has created a virtual energy system consisting of a generator, a photovoltaic system, a battery, and high-performance electronics. The 27-year-old doctoral student has also created computer simulations for three towns and a resort in Malaysia, India, Cambodia and the Philippines to show how such a hybrid energy system can best be run and must be designed for efficient operation. “One of the towns I studied includes an airport and consumes a great deal of electricity daily; numerous photovoltaic modules could supply it,“ explains Sachs. The peak loads in another town occur mornings and evenings. “More batteries would be needed to store extra solar power during the night; peak loads would have to be met with a generator,“ is how Sachs describes the optimum design of the individual components. “The integration of photo-voltaic power and batteries, together with optimized operation of the system, could save up to seven percent of electricity costs, and the high procurement costs would be amortized in three to four years,“ says Sachs.

INTERCULTURAL PITFALLS

Over time, this doctoral student has come to prize the peaceful collision of many nations and cultures where she lives and works. “You have to adapt a lot and adjust to the cultural background of people around you,“ says Sachs. For example, when an Indian colleague typically stresses how important something is just to make sure it gets done at all, he may react with surprise when a “straight-arrow“ German takes him at his word. Has she stumbled into pitfalls? Sachs laughs: “As a guest, I once brought 20 oranges as a gift, instead of the obligatory two oranges.“ But Singaporeans are accustomed to such “faux pas“ and remain unruffled.

Helmine Braitmaier

Industry and Energy: Less is More

Stefan Büttner is making energy efficiency an international affair

For many, "Energy Revolution" means first and foremost renewable energy sources. But using less energy is just as important. Stefan Büttner of the University of Stuttgart is beating the international drum for energy-efficient production. He wants to put this issue in the public eye at the World Climate Summit in December 2015 in Paris.

China, USA, Paris: Stefan Büttner is a much-traveled man in his efforts to lay the groundwork on the world political stage for energy-efficient production. But "Sadly, even now, little heed is being given to this topic," mourns Büttner. That was yet another reason for founding the Institute for Energy Efficiency in Production (EEP) at the University of Stuttgart in 2012. Büttner, who himself graduated in International Economics, is the Institute's Director for International Affairs and Strategy. As an economist, Büttner knows: "Using less electricity and heat means burning less fossil fuels, with fewer greenhouse gases as a result."

By 2020, the German Federal Government aims to reduce Germany's consumption of primary energy by 20 percent and by up to 50% by 2050 in order to meet the target set by the United Nations of limiting the rise in temperature to two degrees centigrade by 2050. However, compliance with these cutback targets will be almost impossible under current conditions, as a German EEP metastudy on energy efficiency has shown. So it will be well worth while to utilize efficiency potentials while are still lying dormant in industrial production facilities which, after all, consume nearly a third of all energy used.

This all the more so inasmuch as a cost-conscious approach to energy sources means more money in a company's pocket. A study commissioned by the Federal Minister for Economic Affairs showed, for example, that investments of only five billion Euros for energy efficiency could result in savings of up to 20 billion Euros in energy costs by the year 2020. That looks like a rather conclusive argument. We have to find out why some companies are still not making efforts to save energy," says 35-year-old Büttner.

INCENTIVES FALL SHORT

For that reason the EEP joined the German Energy Agency, the Federal Association of German industry, the Fraunhofer IPA, and the Rhineland TÜV, in 2013 to start a survey of more than 300 company leaders. The partners wanted to find out where these leaders stand on the subject of energy efficiency and whether they are currently taking steps to save energy or even plan to do so. What came out of this is the Energy Efficiency Index of German Industry, now in its 4th version. And what also emerged in the process was that saving energy is more important to bigger companies than smaller ones. But it also turned out that incentives put in place to date by the government, like subsidies and tax cuts, are only a first step. They are not enough to spur more companies to take action. "The Index enables us to inform companies, lawgivers and financing sources about the current status of energy efficiency in industry while also determining the intrinsic political conditions and better evaluating the risks and potential benefits of investments," explains Büttner. The Index has also caught the eye of an EU task force which deals with investors who play a key role in triggering energy efficiency measures. The EEP now plans to widen its survey of companies to the EU and the G20 countries for a better inter-country comparison regarding energy efficiency.

Keeping an eye on the World Climate Summit in Paris: University of Stuttgart's Stefan Büttner.

The political relevance of the Index and the economic competence of the Institute are helpful in countering presuppositions about them. As Büttner reports, “An academic institution is often regarded as a sort of cloud-cuckoo-land.“ The EEP's aim, however, is not only to publish scientific papers but also to get actively into the thick of the Energy Revolution. For example, the institute is currently helping to implement the “G20-Countries' Plan of Action for Voluntary Collaboration in the Area of Energy Efficiency“, coordinated by the “International Partnership for Collaboration for Energy Efficiency“ (IPEEC for short) in Paris.

“COORDINATING 20 NATIONS IS NO EASY TASK“

Among other things, Büttner works on the international level to help propagate energy management systems in industry. Companies are asked to analyze where energy is consumed by them internally and where savings are possible. In addition, the aims are better networking of businesses and experts and moving financial institutions to provide more money for energy efficiency projects. At the end, a report with recommendations must be approved by all G20-countries and incorporated into the deliberations of the World Climate Summit in Paris. “Our task is to coordinate 20 nations who sometimes have different work philosophies. The fact that only 16 are members of the IPEEC doesn't make it easier,“ says Büttner. Similar goals, but now on the worldwide stage, are targeted by the “Sustainable Energy for All“ initiative which was set in motion by UN General Secretary Ban Ki-Moon and in which Büttner is also involved. It strategically builds contacts in the arenas of politics, business, and civil society in order to chart a joint course towards energy access for all human beings by 2030, double the share of renewable energies, and significantly improve energy efficiency. The personnel of this Initiative will moderate the energy efficiency discussions. And what about energy efficiency in companies located in the different areas of Germany? Büttner, who one worked at Scotland's Parliament and rose there from trainee to office director and has also worked on energy efficiency programs in Scotland and on the energy concept of the USA, says, “Germany is in very good shape. Even so, we must make business people more aware of energy efficiency and also, for example, create more trust in energy consultants.“

Helmine Braitmaier

Holding a Match to Plasma

Fusion research opens the door to future energy

Currently, the discussion about the Energy Revolution centers above all around the development of renewable energy. In the long term, however, the energy needs of earth's growing population cannot be met with renewable energy alone. "If we think of time as a scale, nuclear fusion should be an important source of energy by the 50-year mark," says Dr. Walter Kasparek with conviction. He is a physicist directing one of the three task forces working on fusion research and the industrial applications of plasma techniques at the University of Stuttgart's Institute of Interfacial Process Engineering and Plasma Technology (IGVP).

The fusion of atomic nuclei into a new nucleus is what makes the sun function and turns that star into a gigantic energy source. On earth, however, the use of nuclear fusion is one of the unfulfilled promises for producing energy in a more environmentally friendly way than would be possible with nuclear reactors or coal-fired power plants. A fusion reactor heats heavy hydrogen atoms to more than 100 million degrees centigrade and captures them with a magnetic field in an enclosed volume. At this temperature, the hydrogen nuclei separate from the electrons, a state called "plasma". If the hydrogen nuclei can now be brought close enough to fuse with each other, a comparatively large amount of energy is liberated. Thus a fusion reactor generates energy by uniting lightweight elements into heavy ones - exactly the opposite of today's nuclear reactors, which are based on the principle of nuclear fission. Fusion reactors emit no greenhouse gases, are backed by a quasi-inexhaustible supply of fuel, leave no long-lived radioactive wastes behind, and are safer than nuclear reactors.

© IPP, Thorsten Bräuer

A view into the Wendelstein 7-X plasma container.

INDISPENSABLE MICROWAVES

However, fusion reactors today are still experimental in character: scientists use them to study the behavior of plasma under extreme conditions. They are, as it were, fusion reactors without fusion. Nevertheless, the scientists can use microwave technology to provide the plasma with energy - which is where Kasparek's task force enters the picture. Kasparek explains: "We developed the transfer technology for Wendelstein 7-X, a German research reactor which will soon go into operation: we found a way to couple the plasma with megawatt-range microwaves and with very little loss over a distance of 60 meters." His team also provides expertise for ITER, the International Research Reactor now going up in Southern France - with simulations for the antennas for heating the plasma and with general consulting activities. "We also use microwaves for diagnosing the plasma, that is, for non-contact measurement of its density and structure," adds Dr. Carsten Lechte. As coordinator at IGVP, and as the one responsible for ensuring that

A color-coded microwave on its way through the "uneven" plasma. The white contours mark disturbances in plasma density.

© University of Stuttgart/ IGVP

© ITER

The nuclear fusion reactor ITER in Cadarache in Southern France is still a vast construction site. Not only the University of Stuttgart, but also the European Nuclear Atomic Association and Japan, Russia, the People's Republic of China, South Korea, India and the USA are participants in moving this major project forward.

next-generation scientists are integrated as much as possible into the Community, he directs Stuttgart's contribution to EU-financed international Master's and Doctor's degree programs in "Nuclear Fusion Science and Engineering". For his part, IGVP scientist Kasparek is certain that microwave technology will be indispensable for reactor startups, including those of future operative fusion reactors: "They're the match, so to speak."

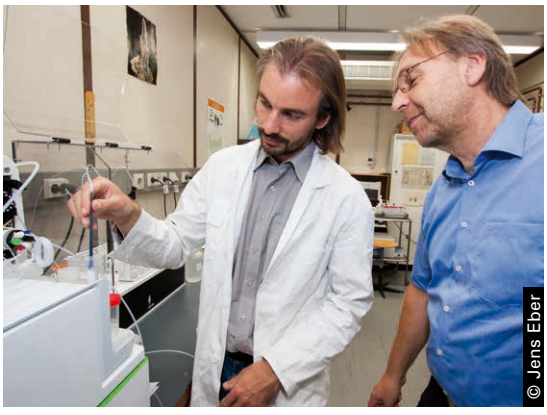
Michael Vogel

From the Mekong to the Andes

Innovatively protecting water as a resource

Every living thing needs water for life; water makes nutrients grow and is a foundation stone of human hygiene. In the absence of sufficient clean water, life itself is endangered. But what happens when industrial effluents, intensive soil tillage, or population growth threaten resources and hamper supplies? Researchers at the University of Stuttgart have been and still are participants in three projects which aim to clear up precisely such questions.

Bedded in a lush green landscape, the Institute for Sanitary Engineering, Water Quality and Solid Waste Management (ISWA) lies in the southwest part of Stuttgart. There's no lack of water here, and that serves as an analogy to the Mekong Delta in Vietnam, one of the "rice baskets" of Southeast Asia and certainly not plagued by a lack of water. On the other hand, the Mekong River is being polluted more and more by liquid wastes. Ralf Minke, Task Area Director for Water Quality Management and Water Supply at ISWA, explains: "Vietnam is undergoing extremely intensive industrialization, much as in Europe 150 years ago. Cities there are growing with an almost unbelievable dynamism." While supplies of raw materials, energy and water for production processes are well organized, the liquid wastes - often highly polluted and sometimes very toxic - are flowing for the most part unpurified into the Mekong and its tributaries.



Manuel Krauß and Ralf Minke (left to right) during laboratory research with the ISWA.

For this reason, a consortium of German and Vietnamese researchers, along with partners from business concerns in the industrial zone of Tra Noc near Can Tho City in the Mekong Delta joined forces in the AKIZ Project (Integrated Effluent Concept for Industrial Zones) to study how the insidious pollution of this important river could be stopped and ultimately reversed. "Our starting point was much the same as in the old industrial parks of the former German Democratic Republic (GDR)," says Project Director Minke. Each industrial zone is to have a central biological wastewater purification plant, and pre-treatment will also be provided for specific tributaries in order to separate useable substances from the wastewater or to generate biogas from the organic wastewater contents and eliminate toxic substances which might disrupt the biological status of the wastewater purification plants.

THE WASTEWATER TREATMENT PRINCIPLE: WHO'S TO BLAME?

"Our basic thought is that individual enterprises should treat their own wastewater on the "Who's to blame?" principle. However, this requires close surveillance and a strong set of environmental protection laws," explains Minke. As a researcher, he is convinced that environmental awareness is certainly present among Vietnamese companies

© Fotolia

There is no lack of water in the "rice baskets" of Southeast Asia, but the ecosystem is threatened by pollution.

- especially when they perceive that new fields of business may open up due to wastewater treatment, e.g. when companies become specialists in wastewater purification or in the retrieval of useable substances. The AKIZ Project, which ran from 2009 to March 2015, resulted in a wide-ranging set of guidelines with recommendations for technically feasible forms of wastewater treatment. "We tried to develop techniques that would work well in the climatic extremes, on location, and under the conditions of the existing level of education", says Minke. He believes that international collaboration requires interested persons who come from all sides. That has also been his experience in Vietnam, says Minke: "Often it depends on individual professors or company heads who keep such international projects moving."
During the Vietnamese industrialization, errors occurred like those in Europe in the 19th century - but now there are much more efficient forms of technology which can stop the consequences more quickly and thoroughly. "The people in the Mekong Delta will certainly benefit from AKIZ," believes Minke. Awareness for environmental problems is growing, and if business enterprises would more sustainably make their products and with more environmental consciousness, there would be reason to hope for long-term jobs. But the researchers' view goes far beyond the Mekong Delta. "The problems apply to many regions in tropical emerging countries, and our solutions should too," says Minke. New types of jobs have also developed in a South China region which for the most part was traditionally without industry. The joint project SURUMER, which brings together German and Chinese partners from research and management, will run there until the end of 2016. The project's target is to develop an integrative land-use concept. The University of Stuttgart's task there is to protect water resources in collaboration with Chinese partners via an integrated management system.

NATURAL RUBBER CULTIVATION

The initial situation found in south China by Manuel Krauß, that is, endangered water resources, resembled the one in Vietnam, but the facts were very different: problems were posed by intensive forestry rather than by high-speed industrial growth in this tropical Chinese region. "The demand for natural rubber has greatly intensified in past decades," explains the academic assistant at the Chair of Sanitary Engineering and Water Recycling. Worldwide production rose by a third. Pressure grew to establish rubber plantations at the cost of natural tropical forests and cultivated landscapes, like old rice terraces, in the area under research - a region with the world's greatest amount of biodiversity. The aftermath there is clear: changes in land use have led to erosion, and

Traces left by the conversion from primeval forests to rice terraces and rubber plantations are visible far into the distance.

valuable soil is being carried away by heavy rains. Pesticides and fertilizers wash into the rivers and groundwater and thus soil drinking water sources as well.

"Our approach is to make rubber cultivation more compatible with nature," says Krauß. But the attitude that mere restrictions suffice to protect nature is not sustainable, he believes as a researcher, because the people there benefit from rising living standards due to rubber cultivation. After the project's launch in early 2012, data above all were gathered - a major challenge in this very rural and indigent region about which nearly no statistics existed. In addition, a monitoring system was set up to provide more precise figures about the impact of rubber monocultures on the water economy. "Our task is to develop concepts; then it's up to the people and local authorities to implement them," says Krauß, who feels it imperative to develop awareness of the inevitable environmental problems. At the same time, he is optimistic as an engineer: "The people see the deteriorating quality of drinking water and note that there are better water sources in still-existing forests." Grass-roots-level work is important here, but without forcing pre-set solutions down people's throats. Then too, the Chinese partners and authorities are very interested in this international collaboration. What's more, "The problem applies equally to many regions, and our solutions must do the same," says Krauß. Thus the growing demand for rubber is creating comparable problems, for example, in Thailand, Vietnam and Myanmar.

BRINGING WATER TO DRY REGIONS

Whereas water is basically plentiful in the Mekong area, challenges that prevail in the Peruvian capital of Lima are very different. The city, with a population of nearly ten million, continues to grow with breathtaking speed, while precipitation which might replenish the water supply is almost nonexistent in this bone-dry geographic region at the foot of the Andes. By far most of the needed water comes down from the Andes in the Río Rímac. This generally sufficed up to now, but nevertheless a project completed in 2014 and called "LiWa" (Lima Water, www.lima-water.de) studied how megacities could be made more self-sufficient in terms of water use. "The problem in Lima is the city's uncontrolled growth together with

Christian León (standing) in discussion with a group of experts in Lima, Peru about steps to be taken in an action plan for supplying water.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© University of Stuttgart, ISWA

A water monitoring station in the catchment area of a Mekong tributary.

scarce water resources," says Christian D. León, a researcher from the University of Stuttgart's Center for Interdisciplinary Research on Risk and Innovation (Zirius), who was born in Lima. He has coordinated the project, which is supported by the Federal Ministry for Education and Research, and acted as an important interface between German scientists from Stuttgart, Magdeburg and Leipzig and the Peruvian project members, who in turn have worked out a plan of action stretching into the year 2040.

They were looking above all for new approaches to water use. "Suppliers usually look only at two possibilities: short-term use of groundwater, or the construction of reservoirs in the Andes," explains León. LiWa set itself the goal of a broader view. "In Lima, as elsewhere, one thinks first of the consumers," states the scientist, especially because per capita consumption is twice that of Germany. "But that is the wrong way to go about it, because it includes great losses due to leaky pipes," says León.

The actions that normally come to mind, like higher water prices, hit hardest at poorer people, who tend to use less in any case. On the other hand, the price is of little interest to well-to-do residents who tend, for instance, to sprinkle their grounds and lawns with precious drinking water. In contrast, the wastewater of this city of millions is pumped directly into the sea. One approach taken by the projects was therefore to purify wastewater much more thoroughly than in the past and reuse it. "It isn't drinkable, of course," says León, but it's well suited to watering gardens and parks." "We also found in Lima-Water that up to 10% less water is to be expected in Río Rímac due to climate change. But that could be countered with intelligent water management and water-saving incentives," is León's firm belief. The technologies are already on hand and need only to be brought together. In addition to adopting a plan of action, the scientists also installed a pilot system for recycling wastewater. León regards it as a victory for the project that he himself, as a Peruvian, was able to work on location. After all, many times he was able to act as a link between the different mentalities and bring South Americans into line with Europeans, thus also creating trust in the respective governmental agencies and gaining the trust of agencies and NGOs on location.

Jens Eber

Breaking New Trails

New Asphalt Mixtures Create Better Infrastructures in Columbia and Elsewhere

Below-zero temperatures and snow, but also long heat waves and nearly 40-degree air temperatures: road pavements in Germany have to be able to take a lot of punishment, and that's why they're so expensive. But even though such requirements aren't present everywhere in the world, the prices are often too high. Now the University of Stuttgart's Institute for Materials Testing (MPA) wants to find solutions for this and can already point to the first pilot projects.

Jan Hofmann, vice-director of the Institute of Construction Materials (IWB), knows that there's much interest in research here. That was shown by inquiries from some of the international students who want to do research work in this area and thus ignited this idea. “Where's there's a need, we shouldn't look the other way.“ One of the first contributions came from the Master's dissertation of Columbia's José Villegas Mosquera in the international Master's Degree program for “Infrastructure Planning“. Roads in Columbia are divided into three categories: the simplest form consists of a layer of gravel topped by asphalt. This is in contrast to Germany's much more complex strategy, where the visible top layer of concrete or asphalt hides crushed rock and frost-resistant layers, a flat layer, and finally the foundation layer - all designed for a much longer service life than in Columbia, where sometimes only a few vehicles use long connecting roads. Since a primary road layer's cost as a proportion of overall expenditures

The international Master's Program in Infrastructure Planning

© University of Stuttgart/MIP

Ever since 1983, the International Master's Program in Infrastructure Planning (MIP) has been offering English-language training with an interdisciplinary character in the area of complex infrastructure planning projects. Worldwide, different aspects of resource conservation must be taken into consideration even as development needs rise, particularly in emerging and developing countries; this requires planning experts with interdisciplinary backgrounds who can also understand the intercultural aspects. That is where the study program's focus lies, with a curriculum which includes traffic behavior, water supplies and drainage, waste management, energy sources, architecture, city and regional planning, but also ecological, social, and management-related aspects like the use of available space. Altogether, 458 students from 79 countries have successfully completed the study program. The number of applicants is high, and the graduates have good career chances everywhere in the world.

The Editors

Antonio José Villegas Mosquera (right) and colleagues at a construction project in Columbia.

here is more than 50% higher than in Germany, it pays to use recycled asphalt in this South American country.

COST ADVANTAGE THROUGH RECYCLING

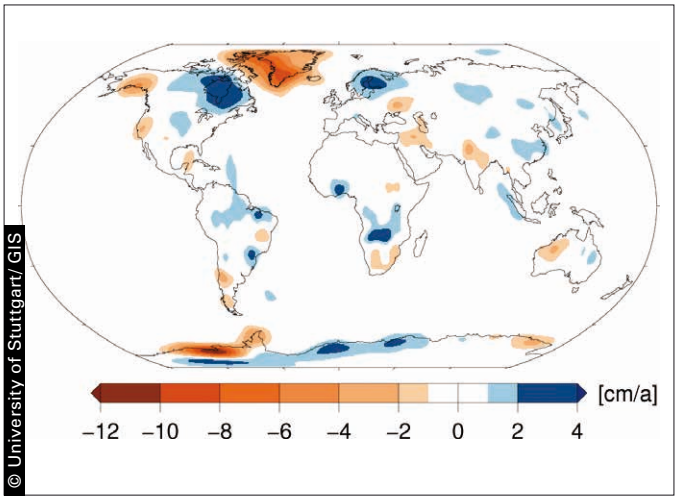
"It truly is cheaper," explains Villegas. And a great deal of energy can be saved during production of the material because, among other things, long-haul transportation is unnecessary when the asphalt is mixed on location. The normal costs per square meter can be reduced by more than 40 percent, even while meeting stipulations regarding materials and processing, says Villegas. His Master's Degree dissertation, which he submitted at the end of 2013, also compared the technical properties of this innovative road pavement with the conventional type. He even found out that the recycled asphalt is longer-lasting. Results of this kind not only need to be applied to other countries but also to be utilized for all students. Thus one female student is currently working in her final dissertation on the possible uses of recycled asphalt for Hungary, and prior to that a Romanian had done much the same research for his own country. These investigations and the results of such Master's Degree studies are incorporated into ongoing lecture classes. Hofmann is also contemplating the possibility of offering a special block of lecture classes in this area for the "Infrastructure Planning" study program, much like what is already being done with an overview of construction materials in individual countries. Hofmann can also conceive of PhD dissertation programs, but then it would probably be difficult to find the corresponding funding for such a task area. The reason: asphalt mixtures draw less interest in Germany, at least with regard to the issues being studied at present. In other countries too, it is not easy to find support for this research - that was another result of Antonio José Villegas Mosquera's investigations. As he explains, roadwork these days is commissioned according to a different system: pavement structures and ecological factors play less of a role, and what is known and familiar is preferred over new-fangled ideas. His new material drew skepticism, not least because it is not yet in widespread use. "It's not easy to change the status quo," says Villegas. The 28-year-old expert made his results available to two companies in his home country, but in the end returned to Germany and now works as a traffic planner. But he's still involved in asphalt: his task area involves construction of "U-Strab", an underground subway system in Karlsruhe, with tunneling going on below the inner city.

Julia Schweizer

A Global Grid

Chinese and German Geodesists Survey the World Together

Geodetic data can indicate coming droughts or natural catastrophes. This branch of science for surveying and charting the world's surface in more dependent than others on international collaboration. With help from the German Academic Exchange Service (DAAD), the University of Stuttgart has launched a project to give impetus to a worldwide network among the community of researchers.



Long-term mass changes in the earth's surface. The orange spot above California gave early warning of today's water shortage there.

Fields dry up, plants wilt - and water grows scarce in California. Strict regulations aim to reduce consumption. But the battle against drought is far from won - even though the dry spell by no means hit this US-state as a surprise. “This situation announced its arrival long in advance,“, say Professor Nico Sneeuw, Director of the University of Stuttgart's Institute of Geodesy. Based on measurement figures sent to earth by satellites for more than ten years, scientists knew early on that water supplies in the southwestern USA were shrinking dangerously.

The case of California highlights the importance which surveying the earth has acquired in recent decades. The compass, the surveyor's staff and the sextant have long ceased to be the Geodesist's most important instruments. Instead, dozens of satellites orbit the earth and generate data which surveying experts capture and evaluate. This process produces more than merely an ever-more-comprehensive picture of our planet. “The idea is also to recognize changes as early as possible,“ says Sneeuw. For example, geodetic data provide early indications of imminent natural catastrophes like landslides or floods. That makes it possible to ward off the collapse of bridges and dam walls. But even more: global problems like climate change or the dessication of whole regions can be seen at an early time. Geodetics deals with global topics and is therefore more dependent than other branches of science on worldwide cooperation among members of the scientific community.

At the University of Stuttgart, the institutes which deal with geodetic subjects have recognized this trend, and have worked for decades to intensify international collaboration. Sneeuw, who was born in Holland, is currently working on an intercontinental expansion of strategic partnerships.

One new network involves the topic area of “Modern Geodetic Space Techniques for Global Change Monitoring“. This is part of an initiative of the German Academic Exchange Service (DAAD), aimed at supporting university-level institutions which want to expand their international

A Chinese-European ESA-Project team (left to right): Professor Jiancheng Li, Professor Weiping Jiang (both from Wuhan), Professor Nico Sneeuw (Stuttgart) and Dr. Oli Baur (Graz), with doctoral students.

collaboration. Interest was great from the moment it was announced: some 90 institutions submitted applications, and 28 of them were accepted into the program - including the University of Stuttgart.

A GIVE-AND-TAKE OF PERSONNEL AND KNOWLEDGE

Five of the institutes and their international partners will now receive a total of one million Euros for four years, provided by the Federal Ministry for Education and Research. This success is also due to the work of the University's Department of International Relations and its long-term support for initiatives of this kind.
The DAAD program's money is not used to hire personnel or purchase equipment. Rather, it serves above all to further the exchange of personnel and knowledge. “About one-third of the funds are used to help Master's Degree students and future professors,“ says Dr. Jianqing Cai, who coordinates the project in Stuttgart. Some of the important partner institutions of learning are in his homeland of China. These include Wuhan University, renowned for its surveying sciences, and Tongji University in Shanghai. It is planned to send five to ten German students there every year to finish their Master's or Doctoral dissertations. Professor Weiping Jiang's institute is one of the project partners in Wuhan. “The cross-border exchange of core knowledge is crucial for scientific success,“ he says. It permits geodetic data from different sources to be combined and evaluated by researchers with different backgrounds. It is especially gratifying that more and more foreign students are coming to Wuhan. The is a turnaround, since in the past it was mostly the case that Chinese researchers spent time at western universities.

INFRASTRUCTURAL ACTIVITIES: A CHINESE DRAWING CARD FOR GEODESISTS

Asia, particularly China, is fascinating for up-and-coming geodesists. The science of surveying is making great strides there: “Wherever you look, freeways, railway tracks, and new city districts are going up“, says project manager Cai. Geodesists are the ones who give planners the data they need. And demand is constantly rising.
The following comparison illustrates the discipline's importance in China: in Wuhan alone more than 50 geodesy professors are at work, bolstered by 150 new scientific employees and 1,000 students per year. In contrast, only five professors work at the University of Stuttgart's Department of Geodetics and Geoinformatics, each with only five team members, almost all financed by outside funds. Of course, “Mass doesn't always mean class“, as Sneeuw freely admits. But time brings respect on both sides for each partner's working methods. “In China, I found that there's a different way of tackling problems than here at home:“

It's quite normal there to assign the same topic to different doctoral dissertations. Even if only one of them reaches the hoped-for result, the goal is regarded - collectively, as it were - as achieved. For Sneeuw, the large number of geodesy experts in China offers an opportunity for partners from abroad. One example is the evaluation of satellite data - a protracted and complicated process, for which personnel is lacking in many European countries. But launching joint projects also requires a growth of mutual trust. The first phase of the DAAD program will therefore aim

IIGS software permits low-cost upgrades of conventional, commercially available GPS equipment, which can then carry out millimeter-precise measurements.

at grounding the network more solidly. “The next step will come in three to four years,“ says Sneeuw. He's thinking of concrete research projects, and feelers are already being put out jointly for funding from other institutions like the German Research Foundation (DFG). There is no lack of weighty arguments which can be advanced - above all in satellite geodesy. Global change around the world puts this science in the spotlight of attention of neighboring disciplines like hydrology, which studies water in the biosphere. The University of Stuttgart's Institute for Modelling Hydraulic and Environmental Systems is also part of the DAAD program, as is also the Institute of Space Systems.

WHAT MAKES THE SEAS RISE?

Rising sea levels play a major role in the debate about greenhouse gas emissions and the global warming which results from them. In the past, geodetic satellites were already showing the melting of ice in Greenland and the Antarctic, together with rising sea levels. These are millimeter-small changes which are very much subject to the influence of tides and which also vary from one location to another. But they can have a significant impact on the global climate. In order to determine these effects, satellites measure the earth's gravitational field and how it changes when masses on the world's surface shift their positions. That happens, for example, when the Greenland ice melts and flows as water to the southern hemisphere. Satellites from the American-German mission GRACE now re-chart the earth's gravity field each month. The data are processed by geodesists and provide important clues for climate researchers regarding sea level rises. One weakness of this method is its low resolution: it can only register areas more than 400 kilometers in size. Moreover, it registers not only daily shifts in water masses but also shifts which are due to tectonic movements, so that measurement of the gravitational field must be supplemented by other methods. These include geometric measurements in which satellites beam down a radar or laser signal and catch its reflection from the ocean. This method also captures fluctuations in sea level.

Students of the English-language Master's Degree program in Geomatics Engineering (GEOENGINE) find it easier to write their Master's and Doctoral dissertations in China.

All of this information must additionally be compared with terrestrial data, such as water level marks or cartographic details. The more data is available, the more complete is the image of the earth. It is not always easy to gather the required geodata. In times past, the data were guarded like military secrets. And in many countries those in possession of them hesitate to release them, fearing that their data will be inferior to those of other researchers. So they keep their information under lock and key. “Mutual trust helps to overcome such hurdles,“ says Sneeuw.

AGREEMENTS AGREED ON DIFFERENTLY

That was the experience of his colleague, Professor Volker Schwieger, who directs the University of Stuttgart's Institute of Engineering Geodesy and works with a great many international partners. Time and again, he finds that agreements are understood differently depending on the home countries of those who are party to them. “In all-German task forces, agreements are clear and are adhered to religiously.“ Foreign colleagues, however, often see the matter less seriously, which often results in a more open, more creative climate. “Teams with an international makeup profit from these differences in ways of thinking,“ says Schwieger. After all, brainstorming is important for work at his institute, where one research project is trying to find out how to make professional GPS receivers affordable. The (freely accessible) position data from GPS satellites shows whether dam walls or bridges are changing shape - and threatening to collapse. However, this requires that the receivers be able display position data with millimeter precision. Such units cost about 20,000 Euros and are financially out of reach for many monitoring stations. Reasonably-priced GPS navigation units for cars are of no help, since they can only show the present position with a precision of only a few meters - too inaccurate to see whether masonry stones are expanding or a railroad bridge is starting to tilt. For that reason, Schwieger and his team have written a software program that makes it possible to upgrade commercially available GPS units and use them for millimeter-precise measurements. This makes the technology affordable for poorer countries as well. Authorities there can recognize danger sooner and avert catastrophes - a concrete result of international collaboration.

Heimo Fischer

A Global Player in Geodesy

The founder of modern earth survey science is an Honorary Doctor of the University of Stuttgart

One of the first geodetic "global players" was planetary geodesist Professor Theodor Albrecht, PhD, who received an Honorary Doctor's Degree from the Technical Academy of Stuttgart in 1913. It was Albrecht who initiated and directed the "International Latitude Service", known today as the "International Earth Rotation and Reference Service". Dr. Andreas Haka of the Department of History of Science and Technology at the University of Stuttgart's Institute of History has studied this pioneer's work as part of his research into planetary geodesy of the 19th and 20th centuries.

The foundations for modern observation of our planet were laid more than 100 years ago, and Carl Theodor Albrecht can be termed one of this science's progenitors. Born in 1843 in Dresden, this scientist wrote his doctoral dissertation and acquired his PhD degree in Leipzig due to his determination of longitude differences with the help of the electrical telegraph. He was one of the first members of the Royal Prussian Geodetic Institute, later became director of the Department of Astronomy, and was named a professor in 1873. The same year saw publication of his first book, named after him the "Albrecht's Tables", which made him renowned worldwide and far beyond the boundaries of his area of expertise and remained the basis for every geodesist's daily work for nearly 100 years.

Around 1895 Albrecht developed a concept for a network of measurement stations around the globe, along with an observation program for studying and charting the movements of the earth. Together with his colleagues Wilhelm Foerster and Friedrich Helmert he campaigned for founding the "International Latitude Service" and worked closely together in this context with Stuttgart Professor Ernst von Hammer: the latter's work for an international earth survey was largely coordinated by Theodor Albrecht in Berlin and was constantly expanded as part of the international Latitude Service.

In 1899 Theodor Albrecht became Scientific Director of the International Latitude Service, along with the Department of Astronomy. He immediately dove into a scientific coordination project unique for its time, with funding from 22 member countries; its effects were worldwide. This marked the beginning of scientific global surveying.

In spite of the plethora of his other offices in Berlin, Albrecht visited all measuring stations of the International Latitude Service and continued his geodetic measurements far into old age, publishing them and presenting them regularly at scientific conferences. Theodor Albrecht died on August 31, 1915 in Potsdam. He is still regarded today as the most successful German earth survey astronomer.

Dr. Andreas Haka/amg

Professor Theodor Albrecht
With friendly permission of the Association for Aid to Students of the Technical University of Dresden

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Urban destruction after the 2015 spring earthquake in Nepal

A Helpful Catastrophe

A Nepalese student has developed an earthquake danger scenario

Researchers at the University of Stuttgart's Department of Attachment and Reinforcement Methods are working with Master's Degree students in Infrastructure Planning to find solutions for making buildings better able to withstand earthquakes. Their scenarios were put to a real-world test by the mammoth earthquake this year in Nepal.

Two days will always remain painfully stamped into the memories of the people of Nepal: the earthquakes of April 25 and May 12 claimed nearly 9,000 dead and more than 20,000 injured, many of them in their own homes, of which half a million were destroyed. But surprisingly these two days can also offer hope for the future - with help from the University of Stuttgart. The reason: researchers can now study whether the risk analyses and earthquake scenarios developed earlier by them as forecasts corresponded to what actually happened. If so, this should help to improve catastrophe protection and show how buildings can be made more stable, based on the calculations. “At present, unfortunately, we cannot carry out a comparison with the actual situation,“ says Professor Jan Hofmann from the Institute of Construction Materials. He acted as advisor four years ago for the Master's Degree thesis of a Nepalese student in the Infrastructure Planning study program. The thesis identified certain areas of the Kathmandu Valley and specific types of building structures as being especially endangered. Closer observation will start in 2016 with the help of students working with “Engineers Without Borders“ and personal contacts with Kathmandu University. “Our colleagues there are occupied right now with crisis management, registering and evaluating the existing damage,“ says Hofmann about the current situation there. ““The issue of earthquakes and earthquake-proofing will certainly keep us busy for the next 20 to 30 years.“

TRIALS ON THE SHAKING TABLE

After classifying the damage, the researchers will attempt to find out what has to be reinforced, and how, and in which types of building structures. “Our research aims above all to find relatively simple techniques that can be implemented directly on location.“ And the research team has already found some of them by means of earlier Master's and Doctor's Degree theses. Some of the work was carried out in the form of 1-to-1 trials on a shaking table at the Bhabha Atomic Research Centre (BARC) in India, with which earthquakes can be simulated. One important result: steel-and-concrete frameworks can be strengthened by means of angular reinforcements in the corners. “It works perfectly. The method is minimally invasive, very reasonable in price, and very effective,“ says Hofmann. It was worked out in collaboration with the University of Canterbury. Steel-and-concrete frames in New Zealand and India have already been reinforced in this way, so that the work of the Stuttgart researchers has also become international in character. Cooperative ventures already exist with the University of Canterbury in Christchurch (New Zealand) and the University of California at San Diego. And earthquake protection is needed here at home as well: on the basis of a new study on the threat of earthquakes in Europe and Turkey, the danger could be twice as high as was previously thought, at least for southern Germany. Data from the 1,000 years were evaluated as part of the SHARE program (Seismic Hazard Harmonization in Europe), and on that basis an endangerment map was created for 120,000 areas - hopefully not to be put to the reality test in the same way as in the Nepal scenario.

Julia Schweizer

Physics and Understanding Among Peoples

Professor Rolf-Dieter Heuer, General Director of the European Organization for Nuclear Research (CERN)

CERN in Switzerland not only has the world's largest particle accelerator (Large Hadron Collider, LHC), but is an extreme "melting pot" of cultures as a major research institution comprising 21 member states and around 12,000 guest researchers from 100 nations. Its General Director, Professor Rolf-Dieter Heuer, studied physics in the 1970s at the University of Stuttgart. He talked with RESEARCH AND LIFE about why science needs globalization and what it gives back to society.

? Professor Heuer, you've headed CERN since 2009 and will pass on the baton at the end of this year to the Italian woman physicist Fabiola Gianotti. What were the milestones during your time, and where did the major challenges appear?

› In 2009 my management team and I set two primary goals for our period in office. The first, quite clearly, was to get the LHC working again after a long period of repairs and retrofitting and use it to implement our physics program. The second was to open up CERN for countries beyond the European region. I always said as a joke, that we had to change the "E" in CERN from "Europe" to "Everywhere". Now, as we near the end of my period in office, I'm happy to say that we have reached both targets. And milestones? Well, milestones for the LHC were clearly the beginning of data acquisition in the year 2009, the first high-energy beams in 2010, our announcement of the Higgs Particle in 2012, and the awarding of the Nobel Prize to François Englert and Peter Higgs the year thereafter. A last LHC highpoint - for the time being - was the successful new startup with higher energy this year, and I'm looking forward eagerly to the exciting physics results which will certainly follow. The challenges which stood in our way to reaching these targets us were very numerous and diverse in character. All the more so inasmuch as I took office just at the same time the economic and financial crisis reached its peak, and with very different financial problems among the 21 member nations. That situation made it difficult for us to keep to our budget. But we succeeded, and all members met their budget obligations - if only with a delay in some cases.

? What has your time at CERN meant for you personally?

› Being tapped on the shoulder to head this institution was a great honor for me, but also a challenge. CERN is a kind of Mecca for particle physicists, and it is truly wonderful to be in this position and to experience and help shape major physics developments in this discipline.
What's more, we were able to make these developments known outside CERN through good public relations work: more people today know what CERN and LHC mean, and that's very important, in my view. People need to see what fascinating work is going on at CERN and what is being achieved with their tax money. That is also a reason why we worked in 2012 for observer status at the UN General Assembly in New York: we want to bring the voice of research and science into the political discussion, and the UN is a venue where we can also have a voice in the task forces.
What especially excites me is the unbelievable diversity of nations and cultures here at CERN. And it works! Everyone pulls together in the same direction. The fact that this is possible is for me one of the greatest successes of CERN.

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"It is wonderful to head CERN and to experience and help shape the major physics developments in this discipline." Prof. Rolf-Dieter Heuer, General Director

? How does work take place in such culturally heterogenous teams?

› Just like everywhere else. When you speak the language of science, an individual's cultural background is no longer so important. People "tick" differently, that's true, even within one and same nationality: you have the "straight arrows", the "powerhouses," and the exceptional persons who think "out of the box". They're all needed. Successful and creative research requires a good balance between the people working on projects and the people looking for new discoveries. It's a structural issue, and also an issue of how much freedom is given to the team members. For me, motivation is an extremely important criterion of management.

? Last summer, experiments with the LHC demonstrated so-called Pentaquark Particles. What's the significance of that discovery?

› Like the discovery of the Higgs Particle, the discovery of the Pentaquark Particles crowned an intellectual adventure that had stretched over several decades. The quark model was worked out in the 1960s in order to describe the vast patchwork quilt of particles observed in laboratories and cosmic radiation. Just as the diversity of chemical elements can be explained in terms of how they are composed of different numbers of protons, neutrons and electrons, much of the diversity of particles is grounded in the fact that they consist of quarks. If we look at the elements, we find that hydrogen, for example, consists of only a single proton orbited by a single electron, whereas gold consists of 79 protons, 118 neutrons and 79 electrons. Similarly, protons and neutrons consist of three quarks, whereas another category of particles, the so-called mesons, consist of one quark and one antiquark. Now, the quark model also predicted that other configurations should also be possible, with five particles, four quarks, and one antiquark. Those are the "pentaquarks".

? What insights are hoped for from this?

› The new results I'm looking forward to most are precision measurements regarding the properties of the Higgs particle. We know that the behavior of the particle we discovered is based on the Brout-Englert-Higgs mechanism, which allows elementary particles to retain their masses. But we still don't know whether we're dealing here with a so-called "standard-model" Higgs particle or or something more exotic. The "standard model" is the theory that we use to describe the elementary particles which make up the visible universe and the manner in which they interact with each other. This is a very good, but also an incomplete theory. For example, it does not explain gravity; and even though the visible

Celebration with the team after the successful restart of the LHC particle accelerator this year.

universe encloses us and everything that we can see, it still makes up only around five percent of everything which composes the universe. The rest is “dark matter“ and “dark energy“, about both of which we still know only very little. Some theories which go beyond the “standard model“ are based on somewhat other properties of the Higgs Particle than those in the “standard model“, meaning that a precise analysis of the Higgs Particle could be very interesting. This also applies regarding a direct search for new particles, since some of those theories that go beyond the “standard model“ predict new particles. Should we see these, that would be a direct proof for dark matter. My hope is that one way or the other we will come upon a new physics - either through precise measurements of the Higgs Particle or through direct searches, and that these will carry us beyond the “standard model“ and into the dark universe.

? Where do you see CERN in 10 years?

› In the same position of excellence as today. We plan for the LHC to run for another 20 years, but we are also planning a major improvement. After collecting data for 10 years at a constant collision rate, we now need another ten years just to double the amount of data which has been gathered. In future we want to achieve this doubling in two years, which will require five times more collisions per second. We want to achieve that by the year 2025 by means of an upgrade which will open the way for another decade. It is also my hope that CERN can advance the topic of an even more advanced particle accelerator. Another important topic for the future is the expansion of CERN beyond the borders of Europe. Just last year, we accepted Israel as our 21st member nation. Romania is expected to follow this year, and Serbia, Turkey and Pakistan have already been accepted as extraordinary members. The last group, for example, has few team members at CERN and fewer contacts with industry, but pays only a fraction of the normal fee. We want to widen this opening, even if it may take longer than I would like. Research is a global affair, and for that reason such institutions should be global in character. And the next machine after the LHC will be a global machine. We'll need human resources for that.

? Does CERN, as one of the first major European research institutions, still set an example?

› That is certain. Over more than 60 years, CERN has shown what can be achieved when Europe pulls together - the political arena could take a page from this book. In the scientific world today, several major research institutions are set up according to the CERN model, such as the European Southern Observatory (ESO) in Garching near Munich, the European Space Agency (ESA), or the European Spallation Source (ESS) which is now going up in Lund in Sweden and will provide neutron radiation for materials research and production material technology. One very exciting research center modelled on CERN is also the SESAME Synchroton Laboratory which is going up in Jordan with UNESCO support. Those participating in addition to Jordan are Pakistan, Turkey, Cyprus, Bahrein, Israel, Egypt, and Palestine. That shows that in the world of science even quite adversarial countries can work together.


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Rolf-Dieter Heuer in the "tunnel" where the world's largest particle accelerator is located.

? Your career started with the study of physics at the University of Stuttgart. What advice would you like to give to your Alma Mater for the future?

› It's enormously important today that scientific institutions don't "live in an ivory tower". Cooperation and competition are not mutually exclusive, quite the contrary. To be successful, the university should concentrate on its strengths, that is, on areas where it has promising topics, good people, and a good research structure. And it should look for the right international partners in these areas. To be an international player, you have to start competing as early as possible and bring good students to Stuttgart from abroad. The German language, however, is very often a stumbling block in this regard. For that reason it's extremely important to offer more English-language instruction classes in the higher semesters. In this regard, it's a good idea to look to Switzerland, where both the students and the teaching faculty are very international.

? In April 2016 you will take over the office of the President of the Germany Physics Society (DPG). What do you envision there?

› At the moment I'm still very much involved with CERN, and for that reason I have no concrete concept for my future task area at the DPG. But two lines of action are emerging: for one thing, I would also like to help shape international networking and put the fund of experience I've gained at CERN to good use at the DPG. And secondly, it's dear to my heart to motivate young people to study the "difficult" subjects like mathematics, physics, and the natural and engineering sciences. This is an area where the DPG can help, for example, through the schools. And I will keep an eye on public relations work.

? And your personal plans for the future?

› I hope to have more influence on my own timetable, to be home more often, to spend more time with my wife, and to take more private trips. But my many side jobs will probably also keep me fully occupied in future. You can't come to a full stop from 100 miles an hour to zero in nothing flat. In one and a half years I'll take over the office of President of the Supervisory Board of SESAME. That is a very important project, particularly also for promoting better understanding among the nations.

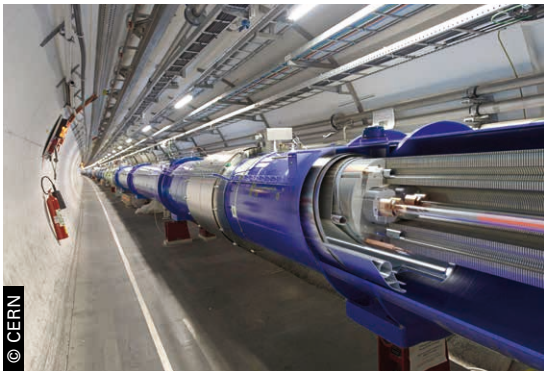
Many thanks for talking to us!

Andrea Mayer-Grenu put the questions.

Reliability Made in Germany

A Stuttgart team analyzes protection mechanisms at the European Nuclear Research Center CERN

The world's biggest machine is located in a tunnel at CERN, the European Nuclear Research Center in Switzerland. It is the Large Hadron Collider (LHC), a very high-performance particle accelerator. More than 10,000 scientists and technicians from more than 100 countries had a hand in building it. The damage was enormous when a technical defect stopped this "World Machine" shortly after it went into operation in the year 2008. Since that time, scientists from the University of Stuttgart's Institute of Machine Components have helped ensure that the LHC functions safely and reliably. They work with a CERN team to analyze weak points that might lead to operational disruptions.



The LHC particle accelerator at CERN, the European Nuclear Research Center in Geneva.

Professor Bernd Bertsche, who directs the Institute of Machine Components (IMA), with responsibility for the institute's Reliability Technology Department, is interested in - failure! Maintaining the proper function of vehicles, production machinery, and factory equipment requires that many components must function as a single system. As today's machines and systems grow ever more complex, however, their builders face more and more imponderabilities: if there is even a minute probability of failure of a single component, the sheer number of components in a complex machine will inevitably lead to operational interruptions. "Our institute studies this type of scenario. Our goal is to reduce the number of situations in which a system breakdown can occur, possibly with grave consequences, and overall to reduce the number of operational problems," explains Bertsche. One of the biggest projects, which has occupied an IMA team for the last three years, is the safety and reliability of the European LHC particle accelerator at CERN. "Our institute has made an international name for itself in reliability research," says Bertsche, "which is why CERN came to us back then." The particle accelerator is located in a 27-kilometer-long, ring-shaped tunnel. Two very high-energy proton beams are generated in the tunnel, race around the ring in opposite directions, and collide frontally at a certain place. This collision releases showers of new particles which provide new insights into the heart of the material universe. Viewed through the eyes of an engineer, the LHC is just a very complex machine. The two proton beams collide with the energy of two ICE railway trains meeting at 150 km/hour. Enormous magnets ensure that the proton beams stay on their circular tracks. The magnetic fields must be so strong that some 12,000 amperes are required - a value possible only with superconducting materials which provide nearly zero electrical resistance. What gave rise to the cooperation between IMA and CERN was most likely an event which occurred in 2008: an accident at the LHC had near-fatal results, fortunately with only material damage. On September 19, 2008,

(left to right:) Volker Schramm, Tobias Griesemer und Miriam Blumenschein, IMA students at CERN in Geneva.

only nine days after startup of the LHC, a weld seam parted, and a tank filled with liquid helium exploded. The explosion heaved a 30-ton magnet 50 centimeters out of position, and the superconducting magnet heated quickly - too quickly. The necessary repairs lasted more than a year.

PERSONAL CONNECTIONS

Says Bertsche, “To help insure the LHC's safety and availability, we work together with two CERN task forces: Machine Protection and Availability,“ says Bertsche, “and use the very same methods as those we employ for commercial machines or vehicles.“ The cooperation also involves personnel: three IMA students are currently at work in Geneva, a woman doctoral student from CERN is in Stuttgart, and Bertsche hopes to set up yet another doctoral candidate position. “CERN is very international in orientation, and the atmosphere and opportunities there are greatly prized by our students,“ was Bertsche's finding.
Dr. Peter Zeiler, Area Director at the Stuttgart IMA, illustrates the fruits borne by this cooperation: “One of our students studied the LHC energy supply's protective system to see where there might be redundancy gaps.“ The reason: systems critical for operation, like the energy supply, are designed in twin pairs so that the failure of one component will have no direct consequences on operation of the LHC. More than 100,000 circuit boards are built into the protective system. “The analysis showed that CERN has heeded the student's results and carried out the necessary steps in the most recent phase of LHC maintenance,“ says Zeiler. Another student carried out an experimental laboratory study of methods for determining the ability of computer storage chips to withstand radiation in the tunnel: “When LHC protons collide, very high-energy particles are generated which can cause bit-errors in electronic components,“ explains Zeiler. Cost reasons dictate that radiation-proof components are often not used in the LHC, for example in the evaluation electronics; for that reason, such studies by the IMA provide valuable insights about the reliability of conventional storage media. And CERN and IMA intend to increase the LHC's availability through yet another research project, since the more measurement time which is available for experiments, the more reliable are the final physical results delivered by the “World Machine“. Currently, the machine is available only about 35% of the time, but a good 70% would be theoretically possible, even taking maintenance times into account.

Michael Vogel

The Clean Way to Fly

Quieter Airplanes, Fewer Emissions

The European Union wants to make flying kinder to the environment and more efficient too: to this end, working with airplane and helicopter makers, it has earmarked billions for the "Clean Sky" and "Clean Sky 2" research programs, in which scientists from the University of Stuttgart are studying possible control components for electrically-powered helicopters.

Electric automobiles may still be exotic on the roads, but their numbers are increasing steadily. The same trend has now caught up with air travel: "More-Electric Aircraft", and/or "All-Electric Aircraft" are the buzzwords, explains Alexander Naubert, Scientific Assistant at the University of Stuttgart's Institute of Engineering Design and Industrial Design (IKTD). The idea behind this: 2.2 billion passengers and thousands of tons of air freight cause emissions every year of 628 million tons of CO2, not to mention nitrogen oxides and incalculable noise. Moreover, it is calculated that air traffic is increasing annually by another four to five percent. That led seven leading European air travel companies ten years ago to decide on a collaboration in the EU's "Clean Sky" Initiative. Their joint goal: the next generation of airplanes must generate far less noise and exhaust gases and make do with less fuel. The participating companies and the EU are putting about 5.6 billion Euros into the "Clean Sky" and "Clean Sky 2" programs - the most comprehensive air travel research effort that has ever existed in Europe.

A ball screw drive of the type already used in the actuators of airplanes.

Electrification is already a reality in model airplanes - they have excellent flight characteristics and long battery lifetimes. However, insights gained from them are not 1-to-1 transferable to manned electric aircraft. "Fluctuations in operating safety have less far-reaching consequences with model airplanes," says Naubert. "But as soon as a human being is on board, certain safety levels become mandatory." The companies participating in "Clean Sky" are doing research on their own or together with others in shared projects worked out with research institutions.

SAFE CONTROLS FOR ELECTRIC HELICOPTERS

Flight control is a key area of technology for the new aircraft, and is precisely the IKTD's area of special expertise, concretely: components for electric helicopters. Rotary-type aircraft are guided by changing the angle of the rotor blades. This is done by means of a so-called "tumbler disk" below the rotor head. This swashplate is moved by actuators and transfers the movements to the rotor blades. Up to now, hydraulic cylinders have been used to achieve this. "But that is no longer feasible in an electrically powered helicopter," says Naubert. This is where this doctoral student's research becomes relevant: instead of cylinders, threaded spindles are used to adjust the swashplate and the rotors in an electrohelicopter. However, threaded spindles can seize up if, for example, they are insufficiently lubricated and wear down as a result. In that case, the helicopter would no longer be steerable. Naubert is therefore studying ways to

(Left to right:) Thomas Münzing and Alexander Naubert at the University of Stuttgart's Institute of Engineering Design and Industrial Design want to make the skies cleaner.

separate a defective spindle as quickly as possible from the swashplate so that a backup spindle can take over its work. In this he is working together with an Italian supplier. He wants to follow up on two possibilities: one variant offers a pyrotechnical explosive charge, much like that used in airbags: an explosive charge would effect the separation; however, the drawback is that the explosion is irreversible, making it impossible to test the functionality of the explosive charge in advance. The other variant under study by Naubert is nondestructive and functions with springs under tension and electromagnets. This kind of system would allow the separation to be reversed during an advance flight test, but for that very reason would possibly be somewhat heavier and have more components, which could in turn themselves malfunction. "We're not quite certain of the final direction we'll take," says Naubert.

TEST OF METTLE FOR THE SPINDLE

Naubert's colleague Thomas Münzing is studying the threaded spindle itself in another project. Normally, it would be designed for continuous operation in machine tools. In the helicopter, on the other hand, it would mostly remain motionless in one position but would simultaneously have to withstand very great hammering impacts from the rotor, comparable to the situation of a jackhammer. Münzing is therefore investigating different production materials, coatings and lubricant types for their useability and wear characteristics. "There's no research available on this special application," says Naubert. Students have also been called upon to work with scientific team members on some of the project's task assignments. "Our men and women students find it very interesting to work on a European project," says Naubert. He hopes to finish his work by mid-2016.
The Airbus Company, which launched these projects, hopes, in its own words, for "trailblazing innovations for the future" from "Clean Sky". Only this type of united effort makes it possible to bundle the best technologies, areas of competence, and resources of know-how in Europe. In the long run, these innovative drive systems could not only make helicopters more environmentally friendly but also cheaper to operate due to the elimination of fuel costs. That would make them an affordable means of transportation for many more people. However, Naubert expects that another 10 to 15 years will pass before this becomes reality.

red

WHO DOES RESEARCH HOW WHERE?

How is research carried out elsewhere? The best way to find out is to begin by studying at another university. Sojourns abroad are not only a springboard to professional careers but also lay the foundations for international research. In addition they foster personal development, multilingualism, intercultural awareness, and both private and international networking.

To give its students a chance to study abroad, the University of Stuttgart maintains a worldwide network with about 315 partner universities around the globe. Our world map here shows the connections. Many of these lines of cooperation - as for instance with Georgia's renowned Institute of Technology in the USA - have already existed for more than 50 years, so that the faculty members know each other and gladly assign thesis topics to students from the other university. There is also a steady flow of international guests - both students and established scientists - to Stuttgart .

This coming-and-going is organized by the University of Stuttgart's Department of International Affairs. The team lays the groundwork for sojourns here, cares for foreign guests during their time in Germany, and helps our own people in make their transition to international research.

amg

Lines of academic cooperation by the University of Stuttgart:

- Europe: about 240 connections with 32 countries
- Asia: 22
- Latin America: 28
- Africa: 4
- North America: 17 direct partnerships and 6 national programs with more than 60 institutions of higher learning
- Oceania: 10

The SUPER summer

American students talk about summer research at the University of Stuttgart

The get-acquainted Stuttgart University Program for Experiencing Research (SUPER) offers - two or three months of rarified research air plus a chance to get to know the University of Stuttgart and its partners, and to take important steps in both professional and personal development – and more!

Already carried out four times by the University of Stuttgart's Department of International Affairs, the program integrates students from foreign partner universities into a research project at a host institution and lets them experience first-hand how we in Germany do research and how we live. But they are not the only ones who acquire intercultural and professional competence; students at the University of Stuttgart also benefit, and many of them become motivated to spend a semester abroad because of these contacts.

Altogether, 19 students took part in this year's SUPER-summer; they came from the Massachusetts Institute of Technology (MIT), Purdue University, and the Universities of Arizona and Toronto. These U.S. "undergraduates" not only learned from their research projects at the various host institutes but also got acquainted with the whole University of Stuttgart and the Fraunhofer and Max-Planck-Institutes. Their schedule included a side-trip to Ingelfingen to visit Bürkert Fluid Control Systems, a market leader in fluids technology which also helps to fund the SUPER-students through its own foundation.

The U.S. guests not only acquired a preliminary taste of research through the program but each also developed his or her very individual "World View". Here are some of their voices.

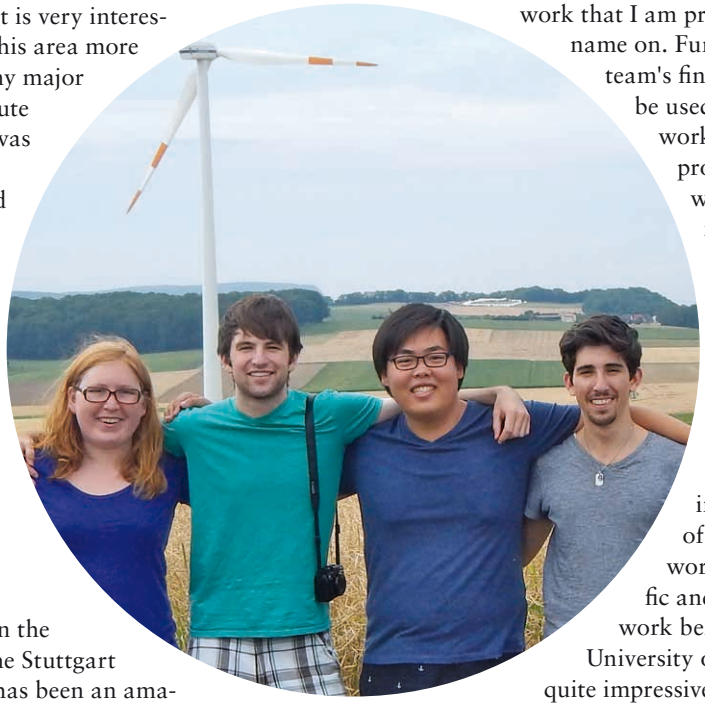
Andrea Mayer-Grenu

CHRISTOPHER JAMES BOBOTSIS, UNIVERSITY OF TORONTO, INSTITUTE FOR TECHNICAL OPTICS (ITO)

My project for this summer at the Institute for Technical Optics was to reverse-engineer an inkjet printer and use the nozzle to shoot a 1pL drop of black ink into the cavity of a micro-optical piece. This darker area helps the lens to function more efficiently. As my time here was only for 2.5 months I unfortunately didn't have enough time to carry out the project until completion, however the work I did accomplish while I was here was interesting! One thing I really liked about the nature of my work was that I was free to plan and organize my work hours. What I didn't like was that the project was difficult at times, as I had never tried taking apart a printer before and didn't really know what to expect. However if I ever ran into any problems I could always talk to my supervisor and bounce some ideas off of him. This almost always helped the project move forward! All in all I enjoyed my research time at the Institute for Technical Optics and definitely recommend it to any future SUPER students!

KATHERINE MAUL AND FRANK MODRUSON IV (BOTH PURDUE UNIVERSITY), ALAN YEH (UNIVERSITY OF ARIZONA), JOSHUA CALAFATO (UNIVERSITY OF TORONTO), STUTTGART WIND ENERGY (SWE)

Alan Yeh: In my home university, there is no wind energy department, so it is very interesting for me to explore this area more in-depth and see how my major of studying can contribute to the project. When I was doing research in my school, I mainly worked in a lab environment. So I really enjoyed being able to go on a field trip and had more hands-on experience. Working with students and faculties with different backgrounds is also a new experience for me.



Frank Modruson IV: For me as an engineer, this summer working on the OpenLidar project at the Stuttgart Wind Energy Institute has been an amazing experience, that has taught me so much, from insight into a new field to lessons in taking advice and the value of teamwork. Starting this project basically from scratch, I learned to consider absolutely everything and to take nothing as given when creating the framework for a project. I also experienced how to step back and look at the big picture, instead of getting bogged down in the details. These skills and lessons have helped me to grow so much over the past three months. They are things that I can carry back with me and apply to my studies and eventually my career.

Joshua Calafato: The OpenLidar project allowed me to work with an international team of students in a range of disciplines. Its outcome is work that I am proud to put my name on. Furthermore, my team's final product will be used for future work in the design project, and it will be used for educating future users of the OpenLidar system. This fact is incredibly humbling, and has helped show me the importance of engineering work. The scientific and engineering work being done at the University of Stuttgart is quite impressive, and through the SUPER program, I was able to experience the technology they are creating. This came through the tours of renowned institutes, like the High Performance Computing Centre HLRS, the Max Planck Institute, and modern architectural designs. These tours not only helped me realize the potential of human endeavor, but also introduced me to the future of our world, and grew my anticipation for this future.

BINGJIE LI, UNIVERSITY OF TORONTO, INSTITUTE OF INDUSTRIAL AUTOMATION AND SOFTWARE ENGINEERING (IAS)

Working at the IAS enhanced both, my engineering and communication skills, living alone for three months made me a more independent person, my numerous trips in Europe opened my eyes and the friendships I have had the fortune to establish in Stuttgart will be cherished for a lifetime. I am very grateful that the program gave me such an incredible opportunity to experience a whole new way of living and learning. I thought settling down in another continent would be difficult and scary, but SUPER made it a lot easier than I expected.

ELAINE CUNHA, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, RESEARCH FACILITY FOR SUBSURFACE REMEDIATION (VEGAS)

It has been a true pleasure working in the VEGAS lab this summer! From the start, they involved me in several aspects of their projects. I prepared small-scale column experiments, assisted with large-scale injections, and participated in field work in the Black Forest. Additionally, I learned how a German university lab operates and was also introduced to different subfields in environmental research. The people at VEGAS are also very welcoming and incredibly fun! I could not have asked for a better summer.

JENNY SHEN, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, INSTITUTE FOR COMPUTATIONAL DESIGN

The SUPER Program exposed me to what a university and research environment is like in Germany, something I had not experienced before. At ICD, we helped with the research pavilion and saw how robotic fabrication, computational design and biomimetics can be bridged together. The project was an interesting, different experience and it was a great opportunity for me to discover a field I didn't know much about.

FERMIN PRIETO, UNIVERSITY OF ARIZONA, INSTITUTE OF INTERFACIAL PROCESS ENGINEERING AND PLASMA TECHNOLOGY (IGVP)

I learned a lot during my research internship at the IGVP and learned even more by meeting incredible people and being an international student at the University of Stuttgart. My research experience and the various institute

tours gave me a really good overview of German engineering and it allowed me to compare it with engineering and research at my home institution. I loved how everyone made me feel so welcomed and the wonderful things Germany and Stuttgart have to offer.
It was truly an amazing way to spend my summer by learning about research, culture and traveling.

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