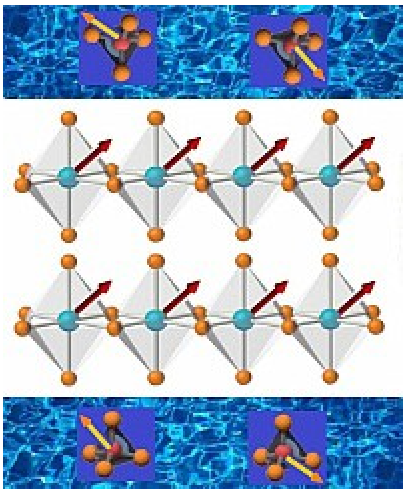
HZDR Online Annual Report 2017

Content



Lattice structure of a spinel
Foto: V. Tsurkan

Imprint

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Words of Welcome

Dear Readers,

The Board of Directors at HZDR:
Prof. Roland Sauerbrey (left)
and Dr. Ulrich Breuer

2017 was a special year for us in several respects. Our Rossendorf Research Center was founded a quarter of a century ago on the site of the former Central Institute for Nuclear Research. Such an anniversary is always an occasion to look back, and this has made us all the more aware of the remarkable development we have already covered. Today, the HZDR is a state-of-the-art, broad-based research center with excellent international connections within the Helmholtz Association.

We have more than twice as many employees as in 1992, and our budget has more than quadrupled. And, to quote our honorary member Prof. Peter Fulde from the Max Planck Institute for the Physics of Complex Systems, Dresden, this is only the beginning. We are still in the midst of the growth phase, closing the year 2017 again with very positive figures: third party funding rose by over 50 percent to more than €37 million, and our staff headcount further increased to almost 1,200.

Yet figures are only one side of the coin. The evaluations for the Helmholtz Association's fourth period of program-oriented funding began in the fall of 2017. All our institutes performed very well in our three research fields – Energy, Health and Matter. This Annual Report gives you an insight into the diversity of our research topics and mentions several scientific highlights of the year under review.

Scientists from more than 50 countries are engaged in research at HZDR – not least because they find excellent conditions for their work here, as well as an outstanding infrastructure. To ensure that this remains the case, we do everything we can to constantly further enhance working conditions and further develop our research infrastructures. We are particularly pleased that our new premises at the Leipzig research site were handed over in 2017. They had been modernized for a total of €10 million and now offer optimum conditions for working with radioactive substances.

The construction work on our “Projects for the Future” continued in 2017 as planned. Here, we would especially like to mention the Center for Radiopharmaceutical Tumor Research, the future European platform for dynamo experiments DRESDYN, and the Helmholtz International Beamline for Extreme Fields (HIBEF). The HIBEF contributes essential components for a novel experiment station at the European XFEL, the world's largest X-ray laser based in Schenefeld near Hamburg.

We launched a new level of international networking in April 2017. In cooperation with the Weizmann Institute of Science, Israel, we decided to set up a joint laboratory in Rechovot near Tel Aviv. The Weizmann-Helmholtz Laboratory for Laser Matter Interaction (WHELMI) aims to bridge the gap between basic and applied research. It will receive total funding of €5 million over the next five years. WHELMI is the first laboratory on the campus of a foreign partner to be co-financed by the Helmholtz Association.

We also laid the foundation for future important research enterprises in 2017 in cooperation with Technische Universität Dresden within the framework of the “DRESDEN concept” alliance: the HZDR was involved in a total of four out of six successful application outlines for clusters of excellence. Construction of the new underground particle laboratory at Felsenkeller has also made a major step forward: the accelerator tank, which was extensively converted by the HZDR for its new task, has been set up at its destination.

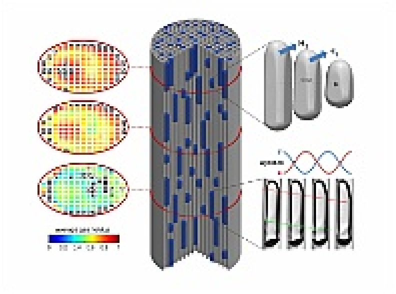
Furthermore, several large-scale projects were launched with substantial HZDR participation in 2017. The HZDR is coordinating the EU's CALIPSOplus project to bundle access to accelerator-based high-performance light sources throughout Europe and to make access easier for Eastern European institutions in particular. A total of 19 partners are involved in the project, which is being funded with €10 million and will run for a period of four years. The League of European Accelerator-based Photon Sources, or LEAPS for short, has a similar objective. By contrast, the EU project INFACT focuses on a completely different subject area. Scientists under the leadership of our Helmholtz Institute Freiberg for Resource Technology want to test new methods of raw-materials exploration and make Europe interesting for the mining industry again.

We hope you enjoy reading our Online Annual Report 2017. The Center's more detailed 2017 Progress Report (Zentrumsfortschrittsbericht, in German only) can also be viewed on request.

Prof. Roland Sauerbrey (Scientific Director) & Dr. Ulrich Breuer (Administrative Director)

Scientific Highlights

Optimized mass transfer in minichannel reactors



Vibrations intensify the transition of gases into the liquid phase because the interface is expanded by the helical capillary waves triggered.

Source: HZDR, Dept. of Experimental Thermal Fluid Dynamics

Today, millions of minichannel reactors with a ceramic honeycomb catalyst are used to clean exhaust gases in motor vehicles. Due to their excellent flow-mechanical and reactive properties, they are also increasingly being used for gas-liquid reactions in the chemical industry. One problem of gas-liquid reactors, however, is the poor solubility of gaseous reactants such as hydrogen or oxygen. Vibrations can help significantly to improve the transition of the gases into the liquid phase.

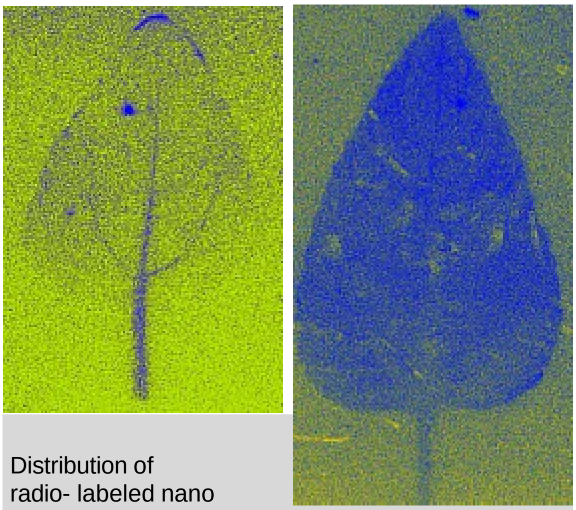
As part of the DFG Priority Program 1506 'Transport Processes at Fluidic Interfaces', HZDR scientists studied Taylor bubble flow in minichannels. The researchers were able to show that electro-mechanical stimulation of the channels can increase mass-transfer rates by up to 186 percent.

For their investigations, the researchers first used high-resolution x-ray microtomography to determine the precise, three-dimensional Taylor bubble shapes and the film-thickness profiles in round and square minichannels. The measured data served as a basis for a review of various numerical simulation methods. In further experiments, the scientists studied mass transfer using hydraulically immobilized individual bubbles of carbon dioxide and oxygen, with and without the addition of surfactants.

Using the data from these experiments, the researchers succeeded in developing more comprehensive models on mass transfer and to prove their validity. In a key experiment, the HZDR researchers studied the mass transfer of individual Taylor bubbles in a round, individual channel, which they set in motion mechanically. The deformation of the Taylor bubble was recorded by high-speed microscopy in addition to the x-ray measurement method. This enabled the researchers to also explain the basic mechanism improving mass transfer: helical capillary waves are triggered by the vibrations at the interface between gas and liquid.

- **Publication:** M. Haghnegahdar et al., Chemical Engineering Journal 326 (2017), 308
  DOI-Link: 10.1016/j.cej.2017.05.138
- **Contact:** Prof. Uwe Hampel, Institute of Fluid Dynamics at the HZDR

How do plants take up nanoparticles from the environment?



Distribution of radio- labeled nano particles along the leaf-veins before (le.) and after dissolving (right)

Source: Stefan Schymura

Nanoparticles are used in many products and industrial processes. However, the potential risks for humans and the environment are still largely unclear. HZDR researchers used radiolabeled cerium dioxide nanoparticles to examine how such particles are taken up by plants. Nanoscale cerium dioxide is used, for example, as an additive for diesel fuels, in exhaust catalysts, and as an UV-absorbing paint additive. The high sensitivity of the usede method enabled the reseachers to study ery low exposure levels that are to be expected in the environment.

In order to differentiate between the uptake and translocation of intact particles and dissolved cerium, the researchers created two different types of chemically and physically identical radiolabeled nanoparticles. In the first case, the radioactive nuclide Ce-139 was evenly distributed in the particles. Cerium-dioxide nanoparticles were directly activated for this purpose using proton irradiation. In the second case, the nuclide Ce-139 was concentrated near the surface. For this purpose, the scientists let the radioactive nuclide diffuse into the cerium dioxide particles at elevated temperatures.

Using the example of ryegrass and sunflowers, the scientists were able to prove that the plants primarily take up intact particles. Furthermore, autoradiographic images of the sunflower leaves also showed that the absorbed nanoparticles are initially transported as intact particles within the plant and, over time, they slowly dissolve and become evenly distributed throughout the leaf tissue.

Although the results cannot be readily generalized to apply to all other particles, the work clearly shows that for a realistic assessment of the environmental risks of nanotechnologies there is no alternative to comprehensive and systematic examinations of the specific uptake routes, and that radiolabeling is a strong tool in gaining this process understanding.

- **Publication:** S. Schymura et al., Angewandte Chemie International Edition 56 (2017), 7411
  DOI-Link: 10.1002/anie.201702421
- **Contact:** Dr. Stefan Schymura**,** Institute of Resource Ecology at the HZDR, Research Site Leipzig

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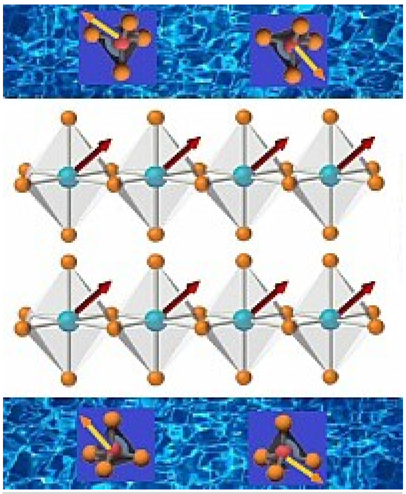
Magnetic frustration makes crystals superfluid and supersolid



Manganese-chromium sulfide has the typical spinel crystalline structure. A strong magnetic field is able to decouple the substructures of the lattice.
Source: V. Tsurkan

Can a material be solid and liquid at the same time? Theoretical physics has been predicting such 'supersolid' phases for over 50 years. Although final experimental proof has yet to be furnished, scientists from the HZDR and the University of Augsburg have now found significant indications that such conditions really do exist. In a manganese-chromium-sulfide crystal they found extremely unusual spin orders, which form as a result of what is known as magnetic frustration. Frustrated magnets represent a promising way of generating exotic quantum states - e.g. spin liquids, spin ice, or complex spin molecules. In an external magnetic field, defined spin patterns can form which are stabilized by field-induced disturbances.

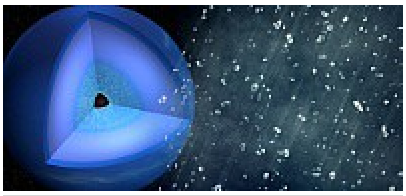
In the manganese-chromium sulfide ($MnCr_2S_4$), the chromium spins align themselves parallel to the external magnetic field. Due to magnetic frustration, the manganese spins exhibit different types of transverse and longitudinal order, which, by analogy with other known (bosonic) systems, can be described as superliquid and supersolid phases.

Two surprising properties became apparent during the magnetization and ultrasonic experiments in the examined material up to 60 tesla. First, a very robust magnetization plateau with an unusual spin structure was revealed. Second, two transitional phases were observed, indicating the possible occurrence of supersolid phases.

The magnetization plateau corresponds to the full polarization of all chromium moments without the participation of manganese. At 40 tesla – in the middle of the plateau – sound waves spread almost without loss: the external magnetic field here exactly compensates the chromium-manganese exchange field, so that the chromium and manganese sublattices are decoupled. By analogy with predictions of the quantum lattice-gas models, the changes in the spin order of the manganese ions on the edges of the magnetization plateau can be interpreted as transitions to supersolid phases.

- **Publication:** V. Tsurkan et al., Science Advances 3 (2017), e1601982, DOI-Link: 10.1126/sciadv.1601982
- **Contact:** Prof. Joachim Wosnitza, Director Dresden High Magnetic Field Laboratory (HLD) at the HZDR

Diamonds form in the interior of gas planets


Inside Neptune, the pressure is so high that carbon compounds are turned into diamonds.
Source: Greg Stewart / SLAC National Accelerator Laboratory

The great ice planets of our solar system – Neptune and Uranus – contain traces of hydrocarbons such as methane in their atmospheres, and far larger quantities are suspected inside these planets. For decades, astrophysicists have been speculating about the processes that take place inside these planets. As pressure increases and temperatures rise from the surface towards the core, complex hydrocarbons such as polymers can be expected to form first. When the hydrogen separates out completely, pure carbon in the form of diamonds can develop, which, due to their density, should sink further into the interior of the planetary core.

Scientists from the Helmholtz-Zentrum Dresden-Rossendorf have now succeeded for the first time in experimentally mimicking these processes. Together with colleagues from Germany and the USA, they were able to show that 'diamond rain' really does develop under the conditions that exist deep inside our solar system's ice giants.

At the Stanford Linear Accelerator Center (SLAC) in California, they exposed polystyrene – a solid hydrocarbon with the molecular formula $(C_8H_8)_n$ – to dynamic pressures of up to about 150 gigapascals and temperatures of approximately 5,000 kelvins. Comparable conditions are to be expected approximately 10,000 kilometers below the planetary surfaces of Neptune and Uranus. With the help of SLAC's ultra-powerful x-ray laser, the researchers were able to observe by x-ray diffraction the process of phase separation with dehydrogenation and the formation of diamonds in situ. They were able to show that very high pressures are required to initiate the separation of carbon and hydrogen.

This suggests that diamond formation requires about ten times higher pressures than previously assumed on the basis of static tests. The results will help to determine the mass/radius ratios of carbonaceous exoplanets more precisely. Furthermore, they provide boundary conditions for their inner layer structure, and help to improve the planet-formation models for Neptune and Uranus, since the influence oft the carbon-hydrogen separation plays a major role on the convective transport of heat.

- **Press release:** In Neptune, it's raining diamonds
- **Publication:** D. Kraus et al., Nature Astronomy 1 (2017), 606, DOI-Link:10.1038/s41550-017-0219-9
- **Contact:** Dr. Dominik Kraus, Institute of Radiation Physics at the HZDR

Squamous cell carcinomas of the head and neck: detecting therapy resistance at an earlier point of time during treatment


FMISO-PET imaging makes it possible to predict at an early stage the effect of combined radiation and chemotherapy in patients with head-and-neck tumors.
Source: NCT Dresden / Philip Benjamin, Anna Bandurska-Luque

Lack of oxygen in tumor cells correlates with poor prognosis in radiation therapy and a lower effectiveness of many anti-cancer drugs, potentially including immune therapy. This relationship has been known for a long time. However, it is difficult to identify patients with hypoxic tumors – preferably prior to the start of treatment or at an early stage during radio(chemo)therapy. In a study, scientists from the HZDR and the University Hospital Carl Gustav Carus Dresden were able to show that persisting hypoxia in the tumor cells in the second week of radiochemotherapy is a predictor of poor prognosis. A total of 50 patients with squamous cell carcinoma were included in the prospective clinical study.

By analyzing the study data, the scientists have now succeeded in proving that positron emission tomography with [18F]-fluoromisonidazole (FMISO-PET) two weeks after the beginning of therapy is suitable as a biomarker for the early detection of persisting hypoxia and thus therapy-resistant tumors. FMISO-PET and computer-tomography images were acquired at four different time-points before and during combined radiation and chemotherapy. The most significant changes in the FMISO-PET signal over the six- to seven-week therapy were seen during the first one to two weeks. The scientists were able to show that patients with a continued lack of oxygen in the tumor as depicted by the FMISO-PET two weeks after the beginning of therapy responded worse to the therapy overall. They had a higher risk of developing recurrences at the site of the primary tumor.

This FMISO-PET-based biomarker for head and neck squamous cell carcinoma, which was developed at the Dresden OncoRay Center, will make it possible in future to identify high-risk patients at an early stage, in order to include them in therapy-intensification studies, for example. These studies are currently being prepared at the University Hospital Carl Gustav Carus.

- **Publication:** S. Löck et al., Radiotherapy and Oncology 124 (2017), 533, DOI-Link: 10.1016/j.radonc.2017.08.010
- **Contact:** Dr. Steffen Löck, – National Center for Radiation Research in Oncology (University Hospital Carl Gustav Carus, Technische Universität Dresden, Helmholtz-Zentrum Dresden-Rossendorf)

Calendar of Events

- **January: Cutting-edge research in three minutes**

Richard Gloaguen at the Science Match in Dresden
Source: Ronald Bonss

At the first Science Match on 'Future Technologies' held on January 26, 100 scientists from leading research institutions in Saxony took up the challenge of presenting their individual research projects to an audience in three minutes. The HZDR nominated eight speakers. One of those chosen among the ten best speakers of the day was Dr. Richard Gloaguen from the Helmholtz Institute Freiberg for Resource Technology, which is jointly operated by the HZDR and the TU Bergakademie Freiberg. He gave a presentation on the use of research drones for raw-materials exploration and mineralogical mapping. Further contributions were made by Prof. Michael Bachmann, Dr. Johannes von Borany, Dr. Sven Eckert, Prof. Uwe Hampel, Dr. Denys Makarov, PhD student Theresa Werner and Dr. Katarzyna Wiesenhütter.

- **February: Teachers attend an advanced-education course in the DeltaX School Lab**

Teachers' further-training course on February 24.
Source: HZDR

'Physics meets Computer Science – Topical Aspects for Science & School' was the theme at the DeltaX School Lab on February 24. Around 50 teachers from all over Saxony accepted the invitation to the HZDR's annual advanced-education course. The program included specialist presentations: Dr. Uwe Konrad, head of the Department of Information Services and Computing at HZDR, spoke on the subject of 'Big Data'; Dr. Michael Bussmann from the Institute of Radiation Physics elucidated scientific computing in cancer research; and Dr. Matthias Streller, head of the Laboratory for Students, introduced the DeltaX Online Platform and its integration into Saxony's online education platform 'OPAL Schule'. During the afternoon, the participants visited HZDR's high-performance computers and the ELBE Center for High Performance Radiation Sources.

March: Excellent conditions for Leipzig-based researchers

Inauguration of the modernized laboratories at the HZDR research site Leipzig
Source: Tilo Arnhold

HZDR's new laboratory facilities in Leipzig were inaugurated by Saxony's Minister President Stanislaw Tillich, together with Thomas Schmidt, Saxony's Minister of the Environment and Agriculture, and Leipzig's Mayor Burkhard Jung on March 22. The HZDR research site at the Wissenschaftspark Leipzig had previously been modernized at a cost of approximately €10 million. State-of-the-art laboratory facilities covering almost 1,000 square meters are available to scientists working with radioactive substances. Basic research is conducted here into the development of neuroradiopharmaceuticals and the behavior of pollutants in complex environmental systems – an essential part of HZDR's nuclear safety and repository research.

April: The particle accelerator is on its way to the Felsenkeller

The particle accelerator is on its way into the Felsenkeller Laboratory.
Source: Oliver Killig

A unique experimental facility is under construction at the Felsenkeller site on the south-western outskirts of Dresden. The HZDR and the Technische Universität Dresden (TU Dresden) are building an underground accelerator in two former ice-storage tunnels of the Felsenkeller brewery. Here, well shielded from cosmic radiation, physicists aim to explore the processes taking place inside stars. The HZDR had already acquired the accelerator tank from a British company in 2012 and refitted it for its new tasks over several years of work. The eight-meter-long and ten-tonne tank was transported by a tractor-trailer right across the city on April 27. It was then installed at its final destination in the tunnel.

May: Radiopharmacists from all over the world meet in Dresden

22nd International Symposium on Radiopharmaceutical Sciences
Source: HZDR/Oliver Killig

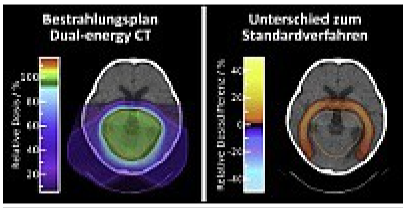
More than 850 scientists attended the 22nd International Symposium on Radiopharmaceutical Sciences from May 14 to 19 in Dresden. The conference, organized by HZDR, focused on new, radiolabeled substances for cancer diagnosis and treatment, as well as the diagnosis of neurodegenerative, neuropsychiatric, and inflammatory diseases. The symposium is staged every two years by the Society of Radiopharmaceutical Sciences; the next one is planned for May 2019 in Beijing, China.

June: Rocket launch in lecture theater

Dresden Long Night of Sciences: HZDR scientists present their research at TU Dresden's Auditorium Center
Source: Oliver Killig

The HZDR took part in the Dresden Long Night of Sciences at four locations on June 16. With numerous experiments and lectures in TU Dresden's Auditorium Center, visitors were given an insight into the wide range of topics covered by HZDR scientists. Special attractions included a laser chess game and a rocket launch using the force of magnetism. Topics relating to cancer treatment were at the focus of attention both at the Dresden site of the National Center for Tumor Diseases (NCT) and at the OncoRay National Center for Radiation Research in Oncology. The HZDR is one of the funding institutions of NCT Dresden and OncoRay. Furthermore, HZDR researchers presented their plans for Germany's deepest underground particle laboratory at the Felsenkeller site.

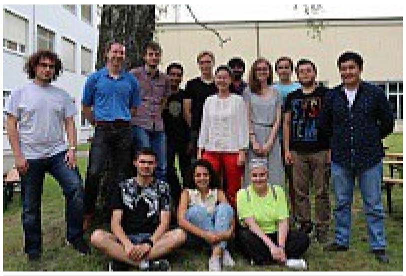
July: Extreme precision in cancer therapy using protons



Dual-energy computed tomography (left) make it possible to reduce the radiation dose in the tissue surrounding the tumor (right).
Source: OncoRay/Patrick Wohlfahrt

In cooperation with researchers at the German Cancer Research Center and Dresden University Hospital, scientists at HZDR's Institute for Radiation Oncology – OncoRay have succeeded in raising the quality of radiation planning for proton therapy to a level that is unique worldwide. They showed the validity of a novel calculation method for determining the range of the proton beam in its application to patients. This was based on a new imaging method for radiation planning that was used in Dresden for the first time: dual-energy computed tomography. Patients of the University ProtonTherapy Dresden have been benefiting directly from the research findings since July 2017.

Summer students from 13 countries at HZDR



Source: HZDR

The HZDR staged its sixth Summer Student Program. 16 young scientists from India, the UK, Poland, Kazakhstan, Germany, Czech Republic, Italy, Portugal, Russia, Kyrgyzstan, Turkey, Ukraine, and the USA came to Dresden for eight weeks at the beginning of August. Here, the participants were able to work on their own research projects and attend lectures on HZDR topics. The program is an essential part of HZDR's program to promote young academics. It aims to provide orientation for the participants in their search for topics for study, master's and later doctoral dissertations. The students were selected by a scientific jury; the minimum requirement is a bachelor's degree or an equal qualification.

September: Network for smart sensors in industrial processes

Doctoral Training Network for novel imaging sensors
Source: TOMOCON

The European Doctoral Training Network TOMOCON was launched on September 1. Twelve research institutions from nine countries are working together on new imaging sensors with 15 well-known industrial companies in a collaborative project coordinated by HZDR. The aim, among others, is to integrate new measuring methods directly into the control and regulation of process-engineering procedures. Modern high-parallel computer architectures are able to process huge amounts of data at high speed. This means that imaging methods can also be increasingly used as sensors to control machines and industrial plants.

October: 25th anniversary of the Research Center in Rossendorf

Prof. Roland Sauerbrey (l.) and Prof. Peter Joehnk at the HZDR Annual Reception
Source: Hans-Günther Lindenkreuz

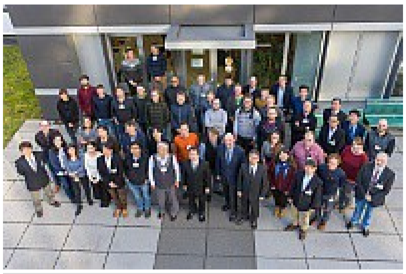
The HZDR celebrated its 25th birthday with two events on October 12 and 13. Two hundred invited guests from the realms of politics, science, and business attended the ceremony to jointly celebrate the 25th anniversary of the Forschungszentrum Rossendorf. The two-and-a-half decades since the establishment on the site of the former GDR's Central Institute for Nuclear Research have been characterized by a remarkable development. Moreover, Prof. Peter Joehnk retired from his long-standing position as Administrative Director. One day later, HZDR launched a scientific symposium. The invited speakers were scientists who had spent important stages of their careers at the Research Center. In short lectures, they also informed the audience about the broad spectrum of research to be found today at HZDR.

November: LEAPS – bundling light for research in Europe

Prof. Roland Sauerbrey at the launch of the LEAPS initiative in Brussels
Source: LEAPS

On November 13, 16 institutions representing 19 high-performance light sources for research across Europe co-founded a joint initiative under the name of LEAPS (League of European Accelerator-based Photon Sources). In the presence of Robert Jan Smits, Director General for Research and Innovation in the European Union and President of the European Strategy Forum on Research Infrastructures, they signed an agreement on enhanced cooperation. Their collaboration aims to improve Europe's scientific excellence and competitiveness. The members of LEAPS run accelerator-based light sources that generate extremely brilliant radiation in the x-ray, UV, and infrared spectra. The HZDR is participating with its ELBE Center for High-power Radiation Sources.

December: Research collaborations with Japan initiated



Workshop at HZDR together with the Japanese partners
Source: HZDR/Detlev Müller

The HZDR agreed to intensify its cooperation with two Japanese research institutions. Director-General Prof. Tetsuya Kawachi signed on behalf of the Kansai Photon Science Institute (KPSI), which belongs to the National Institute for Quantum & Radiological Science & Technology in Japan. The agreement with the Institute of Laser Engineering (ILE) at Osaka University was signed by ILE Director Prof. Ryosuke Kodama. The framework for the agreements was laid down in a two-day scientific workshop on the latest developments in laser and acceleration technology, specifically in research into states of matter with a high energy density like those that exist in the interior of planets or stars.

Knowledge and Technology Transfer

Development of technology transfer at HZDR

Source: public domain

Licenses and third-party funding: The proportion of licensed patents out of the total HZDR patent portfolio has increased to 35 percent. Revenue from licensing again exceeded patent costs in 2017.

Income from the business sector was slightly up on the previous year at over €1.5 million. A large proportion of commercial revenue comes from third-party use of our research infrastructure; the proportion of contract research for industry is smaller. In addition, over €500,000 in income was generated by cooperation with hospitals for the provision of infrastructure and pharmaceuticals manufactured at HZDR.

Innovation projects: In 2017, the HZDR conducted 75 innovation projects with a funding volume of €7.2 million. These included, for example, research-and-development collaborations with the private sector, validation projects, and spin-offs. The number of innovation projects shows that, in addition to cooperation with private enterprise in the form of contract research and infrastructure use, a large proportion of innovation activities involve funded projects. The latter considerably exceed classic bilateral projects with companies in terms of both number and size.

HZDR Innovation Fund: In 2017, the HZDR Innovation Fund financed eight transfer projects, five of which were launched during the year. Overall, the financial scope of all transfer projects supported by the HZDR Innovation Fund in 2017 amounted to €1.539 million. The aim in future will be to make even more intense use of the Innovation Fund to finance validation and spin-off projects.

HZDR Innovation GmbH (HZDRI): HZDR Innovation GmbH (HZDRI) is responsible for service and production orders for the industrial exploitation of HZDR know-how and infrastructure, as well as the equity management of spin-offs. Sales generated by this HZDR subsidiary continued to develop very positively in 2017, especially in its main business area of ion implantation. Based on a total revenue of €2.3 million in 2017, the company generated a record pre-tax profit of over €400,000. To improve quality and productivity and improve the utilization of the beam time provided by HZDR, HZDRI procured new industry-standard wafer-handling systems. A Fraunhofer institute approached the HZDRI with a request to take over the manufacture and marketing of some of its new developments. The HZDRI subsequently concluded license agreements with the Fraunhofer Society for the exploitation of two products.

HZDR-Innovation-Competition: The HZDR ran an internal innovation competition for the first time in 2017. Sixteen transfer ideas were selected from the 20 submitted. In two one-day workshops, the teams developed their ideas up to the presentation stage together with their mentors, and subsequently presented them to a jury. The first three teams were awarded prizes. Validation funding was obtained from the Life-Science Foundation for one of the competition projects at the end of 2017.

BePerfekt: 2017 saw the launch of the project 'BePerfekt – development of an instrument to train people and teams to work in transfer structures'. The aim is to build up training opportunities for German scientific institutions in the field of knowledge and technology transfer. The HZDR is collaborating here with the Karlsruhe Institute of Technology (KIT) and the Potsdam Institute for Climate Impact Research (PIK). BePerfekt is financed by third-party funds from the Federal Ministry of Education and Research (BMBF).

Spin-offs

ERZLABOR

The ERZLABOR project, which has been funded since 2016 by the internal spin-off program of the Helmholtz Association ('Helmholtz Enterprise'), was officially founded as a GmbH in 2017. The young company offers services relating to the qualitative and quantitative mineralogical characterization of solids, including the preparation of rock samples and granulates for analysis. Key customers include mining and recycling companies. Parallel to the spin-off, HZDR concluded a license agreement and a contract for the use of equipment with ERZLABOR. HZDR Innovation GmbH holds 15 percent of the company shares.

Further spin-off projects: On December 31, 2017, HZDR was supervising five potential spin-off projects at an early development stage.

Events

At a meeting entitled 'Unternehmen: wachsen' ('Growing Companies') held in December 2017, spin-offs from the Dresden region presented their projects and told their corporate stories. They subsequently had an opportunity to talk to participants, who included many experienced entrepreneurs. The event was organized within the framework of the 'Unternehmen: wachsen' dialog. This platform, which was initiated by the Federal Ministry of Economy and Energy (BMWi), is part of the Federal Government's project to promote entrepreneurial growth in the new federal states (German title: Förderung von unternehmerischem Wachstum in den neuen Bundesländern).

Contact: Dr. Björn Wolf, Head of Technology Transfer and Legal Affairs at the HZDR

Personnel Matters & Awards

Nominations / Appointments / Functions

- **Stefanie Speidel** was appointed Professor of Translational Oncology Surgery at the National Center for Tumor Diseases (NCT), Dresden on April 1. The computer scientist is engaged in research on intelligent assistance systems for minimally invasive cancer surgery. The NCT Dresden is a joint institution of the German Cancer Research Center (DKFZ), the University Hospital Carl Gustav Carus Dresden, the Carl Gustav Carus Faculty of Medicine at TU Dresden, and the Helmholtz-Zentrum Dresden-Rossendorf (HZDR).

Prof. Stefanie Speidel (NCT Dresden)
Foto: André Wirsig

- In May, Humboldt Research Award winner **Prof. Michael Downer** joined HZDR from the University of Austin, Texas. During a research visit lasting several months, the laser and plasma physics expert worked on methods for improving the visualization of processes in the laser acceleration of particles. The focus is on the development of a new type of particle accelerator that could be significantly smaller than the existing facilities while achieving the same level of performance.
- In June, **Peter Michel** was awarded a W3 professorship at the University of Rostock, where he now holds the chair of Accelerator Technology at the Institute of General Electrical Engineering. The physicist has been head of the Department 'ELBE Radiation Source' at the HZDR Institute of Radiation Physics since 2000. His research activities are devoted equally to the technological further development of the high-performance linear accelerator and to new applications in materials research and life sciences..

Prof. Peter Michel
Foto: HZDR

- **Dr. Constantin Mamat**, Institute of Radiopharmaceutical Cancer Research, qualified as a professor at the Technische Universität Dresden, Faculty of Chemistry and Food Chemistry, with a thesis on 'Bioorthogonal methods for the mild radiolabeling of biologically active molecules with fluorine-18 and other radionuclides using the example of traceless Staudinger Ligation'.
- **Dr. Raimon Tolosana Delgado**, Helmholtz Institute Freiberg for Resource Technology (HIF), qualified as a professor at the TU Bergakademie Freiberg in the field of geosciences, geotechnical engineering and mining. His work bears the title 'Geostatical estimation of ore properties from exploration to adaptive processing'. It is the first time a HIF scientist has qualified as a professor at the TU Freiberg.

- In December, **Prof. Markus Reuter**, Director at the Helmholtz Institute Freiberg for Resource Technology, was awarded an honorary doctorate by the University of Stellenbosch (South Africa). With the award of the title of 'Doctor of Engineering (DEng), h.c.', the University honors Reuter's outstanding scientific and technological contribution to the production and recycling of metals and his special commitment to the practical implementation of academic research.
- The Federal Commission on Radiation Protection (SSK) appointed **Prof. Thorsten Stumpf**, Director of the Institute of Resource Ecology, to the Radioecology Committee. The SSK advises the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) in all matters relating to protection against the dangers of ionizing and non- ionizing radiation.

Awards

- HZDR Awards 2017 (award presentation ceremony on January 18, 2018)
- The European Research Council (ERC) has awarded **Dr. Kristina Kvashnina** (Institute of Resource Ecology) an ERC Starting Grant. The physicist will receive €1.5 million for her research over the next five years. Kristina Kvashnina intends to use the funds to decode the basic chemical structure of elements in the lanthanide and actinide group at the ROBL (Rossendorf Beamline) at the ESRF European Synchrotron Radiation Facility in Grenoble, France. These elements include, for example, uranium and plutonium, but also some rare earths.
- The Georg Forster Research Fellowship of the Alexander von Humboldt Foundation enabled **Dr. Masoud Sadeghzadeh** (Nuclear Science & Technology Research Institute, Tehran, Iran) to carry out a two-year research visit under Prof. Peter Brust at the Institute of Radiopharmaceutical Cancer Research, Department of Neuroradiopharmaceuticals at the HZDR research site Leipzig. Since August 2017, the chemist has been conducting research here on the development of special radiotracers for the biochemical characterization of brain tumors by means of positron emission tomography.
- In early September, **Dr. Fernando Garcia** (Universitat Politecnica de Catalunya, Barcelona, Spain) came to HZDR for two years as a Humboldt Research Fellow. He is researching specific questions of fluid mechanics at the Institute of Fluid Dynamics. Together with his host Dr. Frank Stefani, he is studying instabilities in the spherical Couette flow under the influence of an axial magnetic field.
- The young scientist **Kritee Pant** was awarded one of the four coveted 'Young Scientist Awards' of the US WILEY publishing house at the International Symposium on Radiopharmaceutical Sciences (ISRS) in May for her research on nanoparticles. Her research is concerned with upgrading such particles for cancer diagnostics. Several working groups at the Institute of Radiopharmaceutical Cancer Research, the Free University Berlin, and the Monash University of Melbourne (Australia) participated in her work.

Kritee Pant at the presentation ceremony of the WILEY 'Young Scientist Awards"
Foto: HZDR/O.Killig

- The German Physical Society (DPG) awarded **Dr. Helmut Schultheiss** (Institute of Ion Beam Physics and Materials Research) the 2017 Walter Schottky Prize. He received the distinction for his fundamental work on understanding spin-wave propagation in nanostructures and its application in new functional components for the transport and logical processing of information. The prize is endowed with €10,000.
- In September 2017, **Dr. Björn Drobot** (Institute of Resource Ecology) was awarded the PhD Award of the Specialist Group on Nuclear Chemistry of the Gesellschaft Deutscher Chemiker for his dissertation 'Development and evaluation of mathematical methods for the analysis of spectroscopic data on uranyl(VI) hydrolysis'.
- In November 2017, the DPG announced the award of the Georg Simon Ohm-Prize to **Toni Hache** (Institute of Ion Beam Physics and Materials Research). The jury paid tribute to his outstanding thesis in the Master's degree program on nanotechnology at the Westsächsische University – University of Applied Sciences Zwickau. The work bore the title 'Preparation and characterization of spin-Hall-effect-based nano-microwave oscillators'. The prize, which is endowed with €1,500, was presented to Toni Hache at the DPG Annual Meeting in Erlangen, Germany, in March 2018.
- Physics lab technician **Stefanie Sonntag** completed her professional and skilled workers examination with 98 out of a possible 100 points, making her the best trainee in her profession in the entire Federal Republic of Germany. She was honored for this outstanding performance by the Association of German Chambers of Industry and Commerce in December. Thus, for the second year in a row, the best apprentice in the Federal Republic in this profession comes from the Helmholtz-Zentrum Dresden-Rossendorf.

PhD Degrees

The following graduates were finished at HZDR in the report period:

Institute of Fluid Dynamics

Dr. Hans-Ulrich Härting: Characterization of an inclined rotating tubular fixed bed reactor (Prof. Uwe Hampel)

Dr. Tian Ma: A contribution to turbulence modelling in bubbly flows (Dr. Dirk Lucas)

Dr. Hieram Neumann-Heyme: Phase-field modelling of solidication and coarseningg effects in dendrite morphology evolution and fragmentation (Prof. Kerstin Eckert)

Helmholtz Institute Freiberg for Resource Technology

Dr. George Barakos: An assessment tool for the mineability of rare earth element deposits (Prof. Helmut Mischo, Prof. Jens Gutzmer)

Institute of Ion Beam Physics and Materials Research

Dr. Agnieszka Bogusz: Development of novel $YMnO_3$-based memristive structures (Prof. Sibylle Gemming)

Dr. Nico Klingner: Ionenstrahlanalytik im Helium-Ionen-Mikroskop (Prof. Jürgen Faßbender)

Dr. Alireza Heidarian: Study of the static and dynamic magnetization across the first order phase transition in FeRh thin films (Prof. Jürgen Faßbender)

Dr. Martin Kopte: Spin-orbit effects in asymmetrically sandwiched ferromagnetic thin films (Prof. Jürgen Faßbender)

Dr. Manuel Langer: Spin waves: The transition from a thin film to a full magnonic crystal (Prof. Jürgen Faßbender)

Dr. Robert Wenisch: In situ and ex situ investigation of transition metal catalyzed crystallization of carbon and silicon thin films (Prof. Sibylle Gemming)

Dr. René Wutzler: Integration of III-V compound nanocrystals in silicon via ion beam implantation and flash lamp annealing (Prof. Manfred Helm)

Dresden High Magnetic Field Laboratory

Dr. Johannes Klotz: Untersuchung der Fermi-Flächen stark korrelierter Elektronensysteme und NbP (Prof. Joachim Wosnitza)

Institute of Radiopharmaceutical Cancer Research

Dr. Claudia Barthel: Zur Ligandenentwicklung für den vesikulären Acetylcholintransporter im Gehirn (Prof. Jörg Steinbach)

Dr. Mathias Kranz: Use of small animal PET-MR for internal does assessment (Prof. Peter Brust)

Dr. Jens Lenk: Biochemische Charakterisierung ausgewählter Rezeptor-Ligand- und Enzym-Inhibitor-Systeme mittels Oberflächen-Plasmon-Resonanz-Spektroskopie (Prof. Jens Pietzsch)

Dr. Kritee Pant: Dentritic Polyglycerols for multimodal imaging and therapeutic applications (Prof. Jörg Steinbach)

Dr. Christoph Tondera: Multiskalige multimodale Bildgebung zur Charakterisierung inflammatorischer Prozesse bei der Wechselwirkung polymerer Biomaterialien mit dem Organismus in vivo und ex vivo (Prof. Jens Pietzsch)

Dr. Robert Wodtke: Transglutaminase 2 als molekulares Target zur funktionellen Bildgebung von Tumoren - Untersuchung zu Inhibitoren und fluorogenen Substraten (Prof. Jörg Steinbach)

Institute of Radiooncology - OncoRay

Dr. André Deparade: Therapeutische Wirkung des Polo-like-Kinase-1-Inhibitors BI 6727 (Volasertib(R) unter fraktionierter Bestrahlung an zwei humanen Tumor-Xenografts (Prof. Mechthild Krause)

Dr. Pia Hönscheid: The role of neuropilin-2 on initiation, progression and therapeutic response of colorectal and prostate cancer (Prof. Mechthild Krause)

Dr. rer. medic Steffi Liebscher: Die Bedeutung von VEGF-C und NRP-2 für die Strahlenresistenz im Prostatakarzinom (Prof. Mechthild Krause)

Dr. Johannes Petzold: Toward the clinical application of the prompt gamma-ray timing method for range verification in proton therapy (Dr. Guntram Pausch)

Institute of Resource Ecology

Dr. Stefan Hellebrandt: Grenzflächenreaktionen von Actiniden an Muskovit (Dr. Moritz Schmidt)

Dr. Isabell Hilger: Influence of microstructure features on the irradiation behaviour of ODS Fe14Cr alloys (Dr. Frank Bergner)

Dr. Alexander Hoffmann: Numerical simulation of thermal fluid dynamics of line-focused solar power plants with direct steam generation (Dr. Bruno Merk / Dr. Sören Kliem)

Dr. Lars Holt: Improvement and validation of a computer model for the thermo-mechanical fuel rod behavior during reactivity transients in nuclear reactors (Dr. Ulrich Rohde)

Dr. Dzianis Litskevich: Development of an advanced neutron transport solver for zooming in DYN3D (Dr. Bruno Merk / Dr. Sören Kliem)

Dr. Juliane Schott: Untersuchung der Komplexbildung im An(III)/Ln(III)-Borat-System (Dr. Astrid Barkleit)

Dr. Arne Wagner: Long-termn irradiation effects on reactor pressure vessel steels - investigations on the nanometer scale (Dr. Frank Bergner)

Department of Research Technology

Dr. Philipp Födisch: Instrumentation of CdZnTe detectors for measuring prompt gamma-rays emitted during particle therapy (Prof. Peter Kaever)

Online Annual Report 2017: HZDR Facts and Figures

(as of Dezember 31, 2017)

Total annual budget including investment	approx. 137.4 million Euros
of that, external revenues	approx. 34.6 million Euros

Number of employees	1 179
including PhD students	161
including trainees	39

Professorships	30
including joint appointments at Saxon universities	10
including adjunct and honorary professorships	5

Junior Research Groups (as of 2018)	9
including groups externally funded in competition with other organizations	5
ERC Grants	currently: 2 in total: 4

Publications	
Articles (ISI-/Scopus cited)	599
Other cited publications	24
Books / book chapters	3
Doctoral theses	38

Large-scale scientific facilities (Helmholtz performance category II)	
Ion Beam Center IBC	14 385 hours

ELBE - Center for High-Power Radiation Sources	4 320 hours
Dresden High Magnetic Field Laboratory HLD	104 measurement campaigns / 172 measurement weeks / 6 333 applied magnetic pulses

Science and technology transfer	
Applications by priority	14

Students at DeltaX School Lab	approx. 3 300