Online Annual Report 2016

Simulation of Lonsdaleit (Picture: HZDR)

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Inhalt

Imprint

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Online Annual Report 2016: Address from the Board of Directors

Dear Readers,

The Board of Directors at HZDR: Prof. Roland Sauerbrey (left) and Prof. Peter Joehnk (Source: NCT Dresden/Philip Benjamin)

At the Helmholtz-Zentrum Dresden-Rossendorf, the year was characterized by many important research results and successes. A selection of these we would like to present to you in this online annual review: Scientific highlights from our three research areas of Energy, Health and Matter, major awards, such as the Deutsche Physikalische Gesellschaft's Walter-Schottky-Prize, the Behnken-Berger-Stiftung's first prize or the Prize for the best Physics Laboratory Assistant Qualification, new research and infrastructure projects as well as successes in technology transfer.

In June 2016, our Helmholtz Institute Freiberg for Resource Technology moved to its own research site. Now, the laboratories there can also be used by scientists and students from the TU Bergakademie Freiberg. We were able to deepen our collaborations with the technical universities in Freiberg, Dresden and Chemnitz, thanks to new, joint professorial appointments. Moreover, more than 50 talented junior researchers received the doctoral degree from one of the Saxon universities in the last year based on the Ph.D. theses they produced at the HZDR.

We were very pleased with the further stabilization of the OncoRay - National Center for Radiation Research in

Oncology by funds from the Federal Ministry of Education and Research (BMBF). On October 1, 2016, the SONO-RAY collaborative research project started, involving the Leipzig University Innovation Center for Computer-Assisted Surgery and the OncoRay Center in Dresden. The researchers want to treat tumors more effectively in the future using a combination of radiation therapy and focused ultrasound. OncoRay is jointly operated by HZDR, the Dresden University Hospital and TU Dresden. Its importance for the cancer research hub Dresden was emphasized by the visit of Federal Research Minister, Prof. Johanna Wanka, in August 2016. With the new Center for Radiopharmaceutical Cancer Research, HZDR wants to provide its own, significant contribution to international cancer research. Our largest construction project in recent years will be completed soon.

With the expansion and development of both of our high-energy lasers, DRACO and PENELOPE, we have established a leading platform for research into more compact, plasma-based particle accelerators. Our main aim is to provide alternative sources for cancer particle therapy. Indeed, there is still a lot of research and development work to be carried out. With the new performance record set by DRACO - in 2016 it reached a value of one petawatt - as well as PENELOPE, our diode-pumped, energy-efficient laser system, the first trials on animal models are becoming possible. A special kind of matter - warm, dense matter like the kind which is found in the center of planets or stars - is the focal point of the research activities planned at the Helmholtz International Beamline for Extreme Fields (HIBEF). Initial experiments in this “extreme laboratory” using the world’s most powerful X-ray laser, the European XFEL, are planned for 2018.

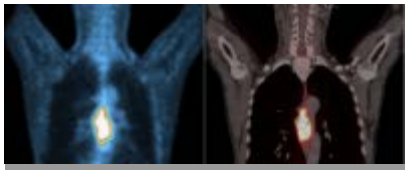
Notable projects on a European level are the EU projects, “Ions4Set”, which works with nanosized construction elements, and TRANSPIRE (Terahertz RAdio communication using high aNistropy SPIn torque Resonators), which is financed by the „Future and Emerging Technologies – Open” (FET Open) program. Both of these projects are coordinated by HZDR and were selected after a very competitive process. The European Magnetic Field Laboratory (EMFL), in which our High Magnetic Field Laboratory Dresden participates, has been awarded landmark status in the European Strategy Forum on Research Infrastructures’ (ESFRI) road map. This illustrates how our scientists are constantly contributing to the international visibility of our work.

We hope you enjoy reading the online edition of our 2016 annual review. The Center’s progress report for past years can also be viewed upon request.

Prof. Roland Sauerbrey (Scientific Director) & Prof. Peter Joehnk (Administrative Director)

Online Annual Review 2016: Scientific highlights

Better quantification of tumor metabolism



PET-Parameter Standard Uptake Ratio (SUR) at patient with esophagus carcinoma
Source: Frank Hofheinz

A new parameter which can be determined from PET images could be an important building block for customized cancer treatment. Researchers at HZDR have developed the Standard Uptake Ratio (SUR), with which tumor metabolism can be quantified more accurately than with the methods currently employed. This facilitates better prognoses for treatment and could be of use in the future for individualized treatment.

Up to now a parameter known as a Standard Uptake Value (SUV) has been used to quantify the tumor metabolism. However, it is very imprecise. Several studies have proven that a considerably better quantification can be achieved using SUR. Whether this also has benefits for patients was investigated by HZDR scientists in collaboration with clinics. Together with the Dresden OncoRay Center

they evaluated the clinical data of 130 patients with a carcinoma of the esophagus. To do this, they correlated the PET parameters and further clinical features of the tumor with how the treatment was progressing.

The study revealed that the use of SUR allowed conclusions to be drawn regarding patients' chances of survival, the risk of remote metastases or the development of a local recurrence. If prognoses like these were possible before the start of treatment, the treatment could be tailored accordingly, for example by using intensified chemotherapy or a higher dose of radiation. As a PET examination is carried out in any case, the SUR evaluation does not add any extra burden. Before the new technique can benefit patients it needs to be tested on a large number of patients in a prospective validation.

- **Publication:** F. Hofheinz et al., "An investigation of the relation between tumor-to-liver ratio (TLR) and tumor-to-blood standard uptake ratio (SUR) in oncological FDG PET", in: EJNMMI Research, 2016 (DOI: 10.1186/s13550-016-0174-y)
- **Contact:** Dr. Frank Hofheinz, Institute of Radiopharmaceutical Cancer Research

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Creating diamond and lonsdaleite using shock-compression

Simulation of Lonsdaleit, an exotic crystal made of carbon, which may arise at a pressure at circa two million atmosphere. Source: HZDR / J. Vorberger

The transformation of graphite into diamond is of major scientific and technological interest. For the first time, HZDR researchers have managed to observe this very fast process, which takes place under extreme conditions. In order to simulate this special form of matter, a graphite sample was bombarded with high-intensity laser pulses. The experiment took place in Stanford, California with the X-ray laser at the Linac Coherent Light Source.

The surface of the material sample is heated extremely quickly by the laser pulses. This generates a shock wave which vigorously compresses and heats the material. For a couple of nanoseconds a warm, dense matter is created that otherwise only occurs in the center of planets or on Earth during a meteorite impact. During the analysis of the experiment at HZDR, clues were found which indicate diamond was formed - or even lonsdaleite, an exotic crystalline carbon which, in its pure form, would be harder than diamond. This structure would result from a shock-compression of around two million atmospheres. The "Helmholtz Young Investigator Group "Dynamic Warm Dense Matter Research with HIBEF", led by Dr. Dominik Kraus, is currently researching how much of the structure remains following the bombardment. As nano-diamonds are used in medicine, amongst other industries, the controlled creation of diamonds and lonsdaleite has a considerable application potential.

For this kind of research, the HZDR is building the Helmholtz International Beamline for Extreme Fields (HIBEF) at the European XFEL in Schenefeld, near Hamburg. From 2018, scientists there will carry out investigations under extreme conditions, such as high pressures, temperatures or electromagnetic fields. Two new lasers will then be ready, with which material samples can be effectively compressed and heated.

Publication: D. Kraus, A. Ravasio, M. Gauthier, D. O. Gericke, J. Vorberger, S. Frydrych, J. Helfrich, L. B. Fletcher, G. Schaumann, B. Nagler , B. Barbrel, B. Bachmann, E. J. Gamboa, S. Göde, E. Granados, G. Gregori, H. J. Lee, P. Neumayer, W. Schumaker, T. Döppner, R. W. Falcone, S. H. Glenzer, M. Roth, "Nanosecond formation of diamond and lonsdaleite by shock compression of graphite", in: Nature Communications, 2016 (DOI-Link: 10.1038/ncomms10970)

- **Contact:** Dr. Dominik Kraus, Helmholtz Young Investigator Group "Dynamic Warm Dense Matter Research with HIBEF" / Institute of Radiation Physics

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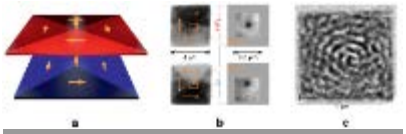
Magnetic vortex cores as tunable spin-wave emitters

Spin waves correspond to the collective fundamental excitations of magnetically



The antenna for the spin-waves is the centre of a magnetic swirl.
Source: Sebastian Wintz, PSI

ordered spin systems. The use of such spin waves as signal carriers in future spintronic information processing devices can substantially reduce power consumption compared to contemporary charge-based technologies, by preventing ohmic losses during the transmission of data. Yet, the coherent excitation of short-wavelength spin waves remained a significant challenge so far.

In this work, it was shown that the nanoscale cores of a stacked magnetic vortex pair can be driven to excite spin waves with wavelengths as short as 100 nm. We directly imaged this process of coherent spin-wave generation and subsequent radial propagation by means of time-resolved x-ray microscopy at the BESSY II synchrotron of the Helmholtz Zentrum Berlin. Thereby, it was also found that the emitted wavelengths can be directly and continuously tuned by the driving signal over a wide range of GHz frequencies. Furthermore, we determined the underlying spin-wave dispersion relation to be linear, gapless in frequency, and strongly non-reciprocal. The magnetic vortex pairs investigated in this study were induced prior to the microscopy experiments by applying ion beam modifications at the Ion Beam Center of HZDR.

Apart from the fundamental importance of the phenomena observed, the obtained results will open a way for the development of new and efficient bias-free non-reciprocal microwave signal-processing devices. At the same time, these results comply with achieving MAG.4 (Characterization and ion beam modification of magnetic relaxation channels in a single sub-100nm nanostructure).

- **Press release:** A Mini-Antenna for the Data Processing of Tomorrow
- **Publication:** S. Wintz, V. Tiberkevich, M. Weigand, J. Raabe, J. Lindner, A. Erbe, A. Slavin, J. Fassbender, „Magnetic vortex cores as tunable spin-wave emitters“, in: Nature Nanotechnology, 2016 (DOI-Link: 10.1038/nnano.2016.117)
- **Contact:** Dr. Sebastian Wintz, Paul Scherrer Institut (PSI) / Institute of Ion Beam Physics and Materials Research

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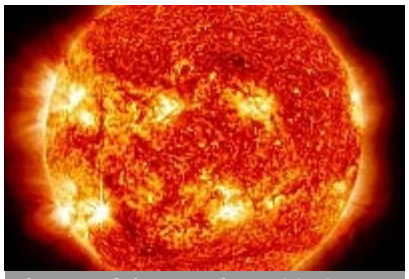
Researchers establish connection between solar cycle and planetary constellation



Picture of the sun from 2012
Source: NASA/SDO

Over a 22-year cycle, solar activity first increases and then decreases. The reason for this is the Sun’s magnetic field which reverses polarity approximately every eleven years. HZDR researchers assume that a specific planetary constellation can set the rhythm for this. They have developed a new theory, according to which planetary tidal forces are sufficient to directly influence the Sun’s activity. Amazingly, the solar field reversal cycle coincides exactly with the periods in which the Sun, Venus, the Earth and Jupiter are in alignment.

The Sun’s magnetic field is generated by the so-called alpha-Omega dynamo. As a result of the differential rotation of the hot conductive plasma, the Omega Effect creates a magnetic field in the form of two rings to the north and to the south of the solar equator. In turn, the alpha effect uses this to generate a magnetic field which runs along the Sun’s lines of longitude, between its poles. Exactly where and how the alpha dynamo originates is currently unknown.

The research team discovered that the alpha effect is prone to oscillations under certain conditions. The Tayler instability, which arises in the Sun’s hot plasma due to the interaction of the magnetic field and the current, plays an important role in this. For the first time, the researchers have found evidence for the Tayler instability also oscillating back and forth between right- and left-handedness. What is special about this is that the reversal happens with no change to the flow energy. This means that small forces are enough to initiate an oscillation in the alpha effect. Calculations show that the very weak tidal forces of Venus, the Earth and Jupiter are sufficient for this.

- **Press release:** Are planets setting the Sun’s pace?
- **Publication:** F. Stefani et al., „Synchronized helicity oscillations: A link between planetary tides and the solar cycle?“, in: Solar Physics, 2016 (DOI-Link:10.1007/s11207-016-0968-0)
- **Contact:** Dr. Frank Stefani, Institute of Fluid Dynamics

Better understanding of geothermal ore forming processes

A geologist during a analysis of stones. Source: HZDR

Most non-ferrous metal ore deposits (lead, copper, zinc, tin) are created by the circulation of hot, often high-saline waters in the Earth's upper crust. Thanks to high temperatures and salinity these solutions can dissolve considerable amounts of different trace elements from rocks which are deep down. These are then precipitated close to the surface due to either cooling, boiling or being mixed with surface waters and form an ore deposit.

In order to detect the deposits deep underground, a good understanding of the geological control parameters which lead to their creation is required. Where did the ore forming waters come from? From which rocks are the metals they contain leached? Which mechanism led to the precipitation of the ore? These are all important factors which are of great significance for the precise localization of a deposit.

An important indication of the nature of the ore forming process is the temperature and the salinity of the waters involved. Geologists who study ore deposits generally use the smallest inclusions of these waters in transparent minerals (quartz, fluorite), so-called fluid inclusions, in order to determine both of these parameters. However, this technique has many limitations. Firstly, the minerals being studied often do not form at the same time as the actual ore minerals meaning that they possibly record different conditions. Secondly, initial investigations only allow for a very spatially restricted analysis as fluid inclusions often only occur along isolated growth areas.

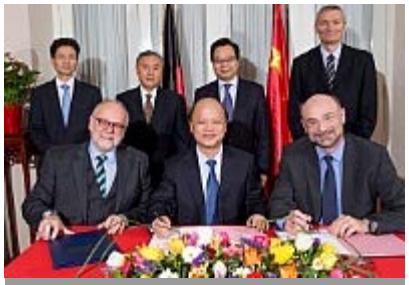
The chemical composition of the ore mineral itself offers an alternative to fluid inclusions. For example, the incorporation of specific trace elements is strongly dependent on the formation temperature. One element - or a combination of elements - can be used to determine the formation temperature. This is generally referred to as a "geothermometer".

Researchers at the HZDR's Helmholtz Institute Freiberg for Resource Technology (HIF) have developed one such thermometer for sphalerite in a new study. Sphalerite, zinc sulfide (ZnS), is the most important zinc mineral and occurs in almost every sulfured non-ferrous metal deposit, usually together with other relevant ore minerals. By means of a meta-analysis of geochemical data it was possible to show that the concentrations of some elements in sphalerite are strongly dependent on temperature. Conversely, this means that it is possible to use these interdependencies as a geothermometer and to better understand ore forming systems by analyzing the ore. The researchers hope to be able to make further minerals, such as pyrite, useful for geothermometry.

- **Publication:** M. Frenzel, T. Hirsch, J. Gutzmer, "Gallium, germanium, indium, and other trace and minor elements in sphalerite as a function of deposit type - A meta-analysis", in: Ore Geology Reviews, 2016 (DOI-Link: 10.1016/j.oregeorev.2015.12.017)
- **Contact:** Dr. Max Frenzel, until January 2018 at the University of Adelaide

Online Annual Review 2016: Calendar of Events

- **January: Extreme laboratory brings researchers from the Far East to Dresden**



Signing expression of interest

With a visit to the Helmholtz-Zentrum Dresden-Rossendorf, representatives of the Chinese Academy of Engineering Physics (CAEP) emphasized their interest in practical collaboration with the Helmholtz International Beamline for Extreme Fields (HIBEF). In the Chinese General Consulate, HZDR Board of Directors, Prof. Roland Sauerbrey and Prof. Peter Joehnk, along with the Vice President of the Committee for Science and Technology at CAEP, Dr. Qiang Wu, signed a memorandum of understanding. From 2018, HIBEF will facilitate research into matter in extreme conditions, such as at high pressures, temperatures or in electromagnetic fields, at

between CAEP and HZDR
Source: Axel Heimken

the European XFEL.

- **February: Energy-saving mini-computer**

Exploring Nano-Worlds
Source: HZDR / Oliver Killig

In the new "Ions4Set" EU project, which started on 1 February 2016, HZDR researchers working with partners from five different European countries want to create a new type of transistor which can transmit information using a single electron. This would greatly reduce the power consumption of nanodevices which are required for the so-called Internet of Things. Previous conceptions of these single-electron transistors only work in very low temperatures. Furthermore, they are not suitable for current microelectronic manufacturing processes. The project, which will be funded with four million euros over a period of four years, aims to develop solutions for this.

- **March: European Magnetic Field Laboratory network receives landmark status**

High Magnetic Field Laboratory Dresden

The European Strategy Forum on Research Infrastructures (ESFRI) has recorded the European Magnetic Field Laboratory (EMFL) as being a landmark in its roadmap. Following the ESFRI's evaluation, it is amongst the top 29 infrastructures in Europe which facilitate scientific research at a world-class level. The EMFL's fundamental idea was to link the four leading European high magnetic field facilities. The EMFL's founding members are the High Magnetic Field Laboratory Dresden, the French Centre National de la Recherché Scientifique, the Radboud University Nijmegen and the Dutch Foundation for Fundamental Research on Matter (FOM).

- **April: DeltaX breaks the five-figure visitor mark**

10.000 guest at the school laboratory DeltaX

Five years after its foundation, the HZDR School Laboratory welcomed its 10,000th guest at the end of April. At DeltaX, pupils aged 10 and upwards can slip into the role of a researcher for a day. The laboratory offers special experimentation days on the topics of magnetism, light and color, radioactivity and radiation. But teachers can also study current research developments once a year at DeltaX. In 2016, around 3,000 pupils toured HZDR - not only from Dresden and the surrounding area but also from other parts of Saxony and Southern Brandenburg. Since it was founded five years ago, DeltaX has been able to more than double its visitor numbers.

- **May: Open House Day draws lots of visitors to Rossendorf**

Open laboratory day

In blazing sunshine, around 3,400 guests took a look behind the scenes of modern research on Open House Day. At over 100 stations, the three hosts, HZDR, VKTA - Radiation Protection, Analytics & Disposal and ROTOP Pharmaka GmbH, displayed their scientific discoveries. In the HZDR laboratories a variety of topics were covered, from the development of radioactive pharmaceuticals for the treatment of cancer, through unique concepts for accelerators and lasers to astroparticle research. VKTA was focusing on questions regarding the dismantling of nuclear facilities and the disposal of radioactive waste. ROTOP Pharmaka GmbH explained about the manufacture of pharmaceuticals for nuclear medicine.

June: Future raw material-research

Source: BBF site office Freiberg GmbH

In mid-June the Saxon Minister of Science, Dr. Eva-Maria Stange, opened the site for the Helmholtz Institute Freiberg for Resource Technology. Since Spring 2014, the listed building had been renovated using Federal funding provided by the Free State of Saxony and the City of Freiberg. Unique laboratories for research along the entire raw material chain are now available to the scientists. Their goal: Finding new means of surveying, processing and recycling high tech metals. The Helmholtz-Zentrum Dresden-Rossendorf and the TU Bergakademie Freiberg jointly founded the institute in 2011.

July: BioMetals draw experts from around the world to Dresden

Dr. Gerhard Geipel organized the Biometals in Dresden Source: HZDR / O.Killig

Together with the International BioMetals Society, HZDR organized a conference on the interdependency of metals in biological systems from 10th to 15th July. At the gathering, which takes place every two years, around 120 researchers discussed a wide spectrum of topics. Starting with the regulation and absorption of metals in organisms, moving on to the interdependency of metals with plants and micro-organisms and finishing with questions about toxicity and protective mechanisms. Furthermore, there was a particular focus on radionuclide behavior - one of HZDR's main research topics.

August: Starting shot for new trainees

Trainee-community at HZDR

For eight young people, their professional lives started at the beginning of August at the Helmholtz-Zentrum Dresden-Rossendorf. This increased the total number of trainees to 42. At the traditional start of the academic year, the graduates also all took their leave. The prize for the "Best Trainee" - which has been awarded by HZDR since 1999 - was received by physics laboratory assistant, Stefanie Sonntag. The center trains people in a total of nine occupations. It also offers dual degree programs in business informatics, radiation technology and information technology. For 16 years in a row, the Chamber of Industry and Commerce Dresden has marked HZDR as a model training organization.

September: Technical Academy receives Innovation Award for Further Education

Source: HZDR / Matthias Rietschel

"Colleagues learn from colleagues" - this is the motto under which HZDR's Technician Academy operates. This further education program is specially geared towards the research center's technical employees. This works by operators, technicians and laboratory assistants passing their knowledge on to colleagues in order to, on the one hand, keep the subject knowledge acquired from the initial training up-to-date, whilst on the other hand enriching it with field references and benefits in kind. This concept, which was developed by HZDR together with the Dresden Society of Environmental Protection Studies and Chemistry, was awarded the Innovation Award for Further Education by the Saxon Ministry of State for Education and Culture at the end of September.

- **October: Sciene under the clear blue sky**

Source: SMWK

At the public celebration for German Unity Day, HZDR presented aspects of its research on the “Science Mile” around the Dresden Frauenkirche from 1 to 3 October. Researchers from the center, alongside with colleagues from the University Hospital Carl Gustav Carus and the TU Dresden’s Faculty of Medicine, drew attention to the potential proton therapy has for cancer treatment. Additionally, scientists from Rossendorf explained how particles can be accelerated using laser power or be made visible with the help of a fog chamber. A total of over 450,000 people visited the public celebration.

- **November: EU funds a leap in the gigabit society**


TELBE-facility at HZDR
Source: HZDR / Frank Bierstedt

The European Union is supporting the development project TRANSPIRE (Terahertz RAdio communication using high aNistropy SPIn torque Resonators) in the “Future and Emerging Technologies – Open” (FET Open) program to the sum of 4.4 million Euro. Within this project, HZDR researchers, together with colleagues from Dublin, Trondheim and Lausanne, want to develop new kinds of transmitters which can transmit data hundreds, or even thousands, of times faster than today’s WIFI networks using radio data transmission. The project as a whole is being led by Trinity College Dublin and the Irish scientific foundation, AMBER. A total of two groups from the Dresden Center are involved in the project, which is funded for four years.

- **December: Routes to CO2-free power supply**


Topic at HZDR: Energy-efficient industrial processes
Source: HZDR / Rainer Weisflog

In order to better combine the various expertises in the field of energy research found within the Helmholtz community, experts from seven Helmholtz centers, including scientists from HZDR, met at the start of December in Berlin. The discussion questioned what contribution the Helmholtz researchers can make to the energy revolution and the decarbonization of the power supply. The experts agreed that this can only succeed with innovative and flexible system solutions which suit the complex requirements of the energy landscape.

Knowledge and Technology Transfer – Online Annual Report 2016

Development of technology transfer at HZDR

Licenses and third-party funding: The proportion of licensed patents out of the total HZDR patent portfolio has increased to 33 percent. In 2016 the licensing proceeds once again exceeded patent costs. An evaluation of third-party funding showed that in 50 out of a total of 64 new projects – all with transfer relevance and an approval volume totaling

Source: public domain

six million euros – the involvement of the HZDR innovation managers was either significant or at least perceptible. This reflects the increasing importance of the innovation manager model as it is implemented at the center.

HZDR innovation fund: The HZDR innovation fund was launched in 2016. It is financed by the Helmholtz Association and the HZDR. The annual endowment is 400,000 Euro. After the Technology Transfer and Legal Affairs Department at the HZDR had established the necessary prerequisites for fund management and administration, the first innovation projects eligible for funding could be selected.

HZDR Innovation GmbH (HZDRI): The subsidiary HZDR Innovation GmbH is responsible for service and production orders for the industrial exploitation of HZDR know-how and infrastructures as well as the equity management of spin-offs. HZDRI once again launched new business areas in 2016 for the exploitation of technologies licensed by the HZDR. Here the measuring technology for magnetohydrodynamics from the Institute of Fluid Dynamics deserves a special mention.

For the further development and expansion of production capabilities at the HZDRI in the field of ion implementation, a letter of intent was signed with the Slovakian Technical University Bratislava – STU and its Ion Beam Center created in partnership with the HZDR. Developing a joint venture in Slovakia is the objective.

GRULA-KMU: The partners in the project to intensify collaboration, "Basic Research-Oriented Universities and Research Institutions with Midsize Companies in the Dresden Science Region" (GRULA-KMU), want to test the role that universities of applied sciences can play as mediators for basic research-oriented organizations such as the HZDR for the purpose of completing value chains and in validation projects. Project partners are TU Dresden, the Dresden University of Applied Sciences, and the ifo Institute – Leibniz Institute for Economic Research at the University of Munich.

Cooperation with Fraunhofer: The HZDR supported the successful application in the Fraunhofer Attract-Program by a former junior research group leader of the HZDR. The junior research group had developed a larger basic research-oriented portfolio with more than 15 patent families at its center. By moving to the Fraunhofer Society, this paves the cornerstone for a comprehensive validation as well as the specific, industry-oriented further development and potential exploitation of the HZDR technologies.

TTO-Alumni: The joint project "Development and Testing of Alumni Networks for Assessment and Exploitation Processes in Science-Related Technology Transfer" (TTO-Alumni) aims to involve former doctoral candidates, students, and employees active in the industry into the daily technology transfer activities at the HZDR. This is an externally funded project that is subsidized by the Federal Ministry of Education and Research (BMBF).The HZDR is cooperating with the Karlsruhe Institute of Technology (KIT) and TU Dresden for the systematic involvement of alumni in transfer activities. An employee was added to the transfer team for the project.

New industry cooperation agreements of the HZDR

Institute of Radiopharmaceutical Cancer Research: In the past year, the HZDR concluded cooperation, delivery, and tenancy agreements with the company ROTOP


Center for Radiopharmaceutical Tumor Research at HZDR
Source: R. Weisflog

Radiopharmacy GmbH that was newly founded and established on the Dresden-Rossendorf campus. These agreements form the basis for establishing long-term cooperation in regard to joint product development and the shared use of HZDR infrastructure. This applies in particular to the new cyclotron in the Center for Radiopharmaceutical Tumor Research.

Institute of Fluid Dynamics: The HZDR concluded a three and a half year research and development agreement with a company in the automobile industry at the beginning of 2016. This strategic partnership is aimed at using fundamental knowledge in order to optimize components in the vehicle through experiments and numerical simulations.

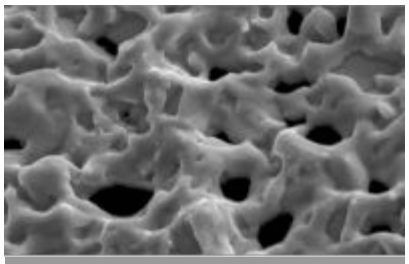
The start of a project subsidized by the Federal Ministry for Economic Affairs and Energy (BMWi) establishes the infrastructure prerequisites for the extended use of the TOPFLOW research infrastructure. A strategic partnership with the company Linde can therefore be established.

A cooperation and licensing agreement with Primetals Technologies regulates the further development and exploitation of a flow-measuring technology patented by the HZDR (CIFT: Contactless Inductive Flow Tomography) for steel strand casting.

Events

In 2016 the center conducted two “Innovation Forums” subsidized by the Federal Ministry of Education and Research (BMBF), where participants discussed possible industry applications of HZDR technologies. “Magnetic separation” turned out to be one of the topics and investigating possible applications for the novel material “BFO” (bismuth iron oxide) was another.

Spin-offs


i3membrane conquers the separation market.

Biconex GmbH: Biconex GmbH, founded in May 2015, successfully completed a first financing round in March 2016 and has been generating initial sales revenues since then. An investment company provided 1.5 million Euro for the further development and marketing of the technology developed at the HZDR for chromium 6-free plastic electroplating. HZDR Innovation GmbH profitably sold its 15 percent share to the investor in this transaction. The HZDR continues to participate in the success of the spin-off through a licensing agreement.

i3membrane GmbH: The spin-off i3membrane GmbH, financed with investment capital, successfully introduced its first products (sterile filters) to the market in the reporting period. Currently the focus is on sales and the expansion of production. The HZDRI still holds more than ten percent of the company’s shares and the HZDR participates in the success of the spin-off through a licensing agreement.

THATec Innovation GmbH: The spin-off THATec Innovation GmbH was founded in September 2016. This company develops and distributes software for the coordination and synchronization of laboratory equipment from various suppliers. Funds from the Helmholtz Enterprise Fund (HEF) and the HZDR Innovation Fund were used to prepare for the spin-off. The spin-off project was also part of the Accelerator Program of the Fraunhofer Society. This test case is intended to establish the basis for closer networking between the Fraunhofer Society and the Helmholtz Association in supporting spin-offs. HZDR Innovation GmbH holds 15 percent of THATec.

Three additional spin-off projects: ERZLABOR is a spin-off of the Helmholtz Institute Freiberg for Resource Technology at the HZDR. HEF funding that commenced on 1 September 2016 was also obtained here. The purpose of ERZLABOR is to provide services for quantitative mineralogical analysis and underlying sample preparation. Initial

sales are being realized through HZDR Innovation GmbH acting as incubator, and business management training is being provided to the founders. The participation of the HZDRI in ERZLABOR is also planned. Finalizing the spin-off depends on successful customer acquisition and is planned to take place in 2017.

The Polcar project which focuses on a novel material system for biological sample carriers, is currently in an early concept phase.

Another spin-off project supported by the HZDR deals with the development and marketing of an innovative measuring device for magnetic field measurements.

Contact: Dr. Björn Wolf, Head Technology Transfer & Legal Affairs at HZDR

Online Annual Review 2016: Personnel Matters & Awards

Appointments / Recognitions / Functions

Discharging of Prof. Michael Baumann, scientific director at DKFZ, and Inauguration of Prof. Mechthild Krause, head of HZDR-Institute of Radiooncology - OncoRay since 1st July 2016. Source: UKD / André Wirsig

- Since June 2016, Cuban scientist **Dr. Yonder Berencén** has been a guest at the Institute of Ion Beam Physics and Materials Research as a Humboldt Fellow. Over the next two years, he will be working on the question of how silicon nanowires can be used as building blocks for electronic and optoelectronic applications.
- **Prof. Olav Hellwig** accepted a professorship for "Functional Magnetic Materials" at TU Chemnitz and the HZDR Institute of Ion Beam Physics and Materials Research at the end of June 2016. The physicist, who moved to Saxony from San Jose in the USA, is working on new kinds of data storage technologies.
- The Brandenburg Ministry for Science, Research and Culture appointed **Prof. Jens Pietzsch** from the Institute of Radiopharmaceutical Cancer Research to the Brandenburg Health Campus' advisory board. The organization's goal is to strengthen university-level research and education in the areas of medicine and health through a visible national network.
- Since 1st July, **Prof. Mechthild Krause** has been managing the Institute of Radiooncology - OncoRay at HZDR. The radiotherapist is also currently the director of the National Center for Radiation Research in Oncology - OncoRay as well as the Clinic for Radiotherapy and Radiation Oncology at the University Hospital Dresden.
- The former director of the HZDR Institute of Radiooncology and the OncoRay Center, **Prof. Michael Baumann**, was appointed Scientific Director of the Deutsches Krebsforschungszentrum (DKFZ) on 1st November. In recent years he has been the driving force behind the Dresden and Heidelberg institutions becoming so well interconnected.
- Together with HZDR, TU Dresden appointed **Prof. Kerstin Eckert** to a professorship for "Transport Processes at Interfaces". The physicist investigates the processes which take place at contact points when gasses, liquids or solids converge.

Awards

- **2016 HZDR Prizes** (awarded 3. Maiy2017)
- In his doctoral thesis, **Dr. Christian Golnik**,

Award of the HZDR-prizes 2016 Source: André Wirsig

discovered a new technique for measuring the range of particle beams during cancer treatment. The innovative and comparatively simple process could make a crucial contribution to making radiation therapy even more effective by using the charged particles. The Behnken-Berger Foundation honored this achievement with its 1st prize of the same name, which has a value of 12,000 Euro.

- In Wilhelm Conrad Röntgen's birth town, Remscheid, the former director of the HZDR Institute of Radiooncology - OncoRay and the OncoRay Center, **Prof. Michael Baumann**, received the Röntgen Medal (see PDF, p. 37) for his outstanding scientific achievements. This honor is awarded to people who have made outstanding contributions to the advancement and circulation of Röntgen's discovery.
- In November 2016, the Deutsche Physikalische Gesellschaft (German Physical Society) awarded the 10,000 Euro Walter-Schottky-Prize 2017 to **Dr. Helmut Schultheiß** from the HZDR Institute of Ion Beam Physics and Materials Research. With this award, the society recognized his fundamental work towards understanding spin wave propagation in nanostructures and their applications in new, functional components for the transportation and logical processing of information. Schultheiß leads the Emmy Noether Research Group "Magnonics" at the research center.
- For the first time ever, the Helmholtz Association has awarded a HZDR doctoral candidate its Doctoral Prize. **Dr. Tobias Vogt** from the Institute of Fluid Dynamics managed to create and analyze a tornado-like vortex in a liquid metal flow during his PhD. Additionally, his engineering knowledge has led to a more efficient blending of molten steel and to the dynamism of Poincaré waves. The prize also includes a 5,000 Euro monthly travel allowance for undertaking a research period in a foreign country.
- For his successes in the field of high-performance computing, the Association for Computing Machinery and the Institute of Electrical and Electronics Engineers have awarded HZDR doctoral candidate, **Axel Hübl** the George Michael Memorial HPC Fellowship, which has a value of 5,000 US Dollar. Along with other junior researchers from Dresden, the physicist was able to develop today's most efficient simulation code for laser and plasma physics.
- The German Research Foundation (DFG) awarded **Dr. Max Frenzel** from the Helmholtz Institute Freiberg for Resource Technology the Bernd Rendel Prize for Geosciences, worth 1,500 Euro. The junior researcher was able to prove in his doctoral thesis that the amount of usable gallium and germanium worldwide is considerably larger than current annual production.
- For her excellent apprenticeship certificate as well as her exceptional operational, social and sociopolitical commitment, biology laboratory technician **Lisa Bauer** received the Professor Joehnk Advancement Award for Trainees. It is awarded yearly by the "Zukunft durch Bildung" ("A Future through Education") foundation and is worth 1,000 Euro.
- With 96 out of a possible 100 points, **Kevin Bauch** was last year's best physics laboratory assistant graduate nationwide. The former HZDR trainee received this honor from The Association of German Chambers of Commerce and Industry (DIHK). Earlier the Dresden and Saxony IHKs (Chambers of Commerce and Industry) had honored him as the best in the local area and the best in state for his excellent results.
- At the 2016 World Media Festival in Hamburg the film about repository research at the HZDR Institute of Resource Ecology was awarded the **Intermedia-Globe in Gold** in the "Research and Science" category. A further prize, the Remi-Award in Gold, was received for the video which the research center produced with Dresden-based company, Avanga at the 49th International Film Festival in Houston, Texas.

Obituaries

- Following a short and serious illness, **Prof. Dirk Schwalm** died on 14 July 2016 at the age of 76. From 1993 to 2000 the physicist was a member of the Scientific Advisory Board at the Rossendorf research center. Since 2012 he had been contributing to the ELBE Advisory Board.
- At the age of 59, **Prof. Leone Spiccia** died on 18 December 2016 in Melbourne. The chemist had worked closely with researchers from the HZDR Institute of Radiopharmaceutical Cancer Research since 2006. In 2014 he received the Helmholtz International Fellow Award.

Promotionen – Annual Review 2016

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

Institute of Fluid Dynamics

Dr. Frank Barthel: Ultraschnelle Röntgencomputertomografie für die Untersuchung von Zweiphasenströmungen (Prof. Uwe Hampel)

Dr. Stephan Boden: Beiträge zur röntgendiagnostischen Visualisierung und Charakterisierung von Erstarrungsvorgängen und zweiphasigen Strömungsphänomenen in metallischen Schmelzen (Prof. Uwe Hampel)

Dr. Dirk Räbiger: Anwendung magnetfeldbetriebener Strömungen zur Kontrolle von Erstarrungsvorgängen in metallischen Legierungen (Dr. Sven Eckert)

Dr. Norbert Weber: Modellierung von Tayler-Instabilität und Elektrowirbelströmungen in Flüssigmetallbatterien (Dr. Gunter Gerbeth)

Dr. Yunhu Zhang: Experimentelle Untersuchungen zum Effekt der Kornfeinung in Al-Si-Legierungen durch die Anwendung elektrischer Ströme (Dr. Sven Eckert)

Dr. Thomas Ziegenhein: Fluid dynamics of bubbly flows (Dr. Dirk Lucas)

Helmholtz-Institut Freiberg for Resource Technology

Dr. Max Frenzel: Geologische und technologische Verfügbarkeit von In, Ge und Ga (Prof. Jens Gutzmer)

Dr. Sophia Kostudis: Bio-chemical leaching of Kupferschiefer sensu stricto ore with organic acids in neutral and alkaline environment (Dr. Katrin Pollmann)

Dr. Christin Kreher: Geometallurgical assesment of the Kupferschiefer-type base metal deposit Spremberg-Graustein, Lusatia, Germany (Prof. Jens Gutzmer)

Dr. Dirk Sandmann: Method development in automated mineralogy (Prof. Jens Gutzmer)

Dr. Oliver Zeidler: Rückgewinnung von Gallium aus Prozessabwässern mit Dialyseverfahren (Prof. Christiane Scharf)

Institute of Ion Beam Physics and Material Search

Dr. Faina Eßer: Cyclotron resonance and photoluminescence studies of dilute GaAsN in magnetic fields up to 62 Tesla (Prof. Manfred Helm)

Dr. Markus Fehrenbacher: Terahertz near-field investigation of a plasmonic GaAs superlens (Prof. Manfred Helm)

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

Dr. Tobias Kosub: Ferromagnet-free magnetoelectric thin film elements (Prof. Jürgen Faßbender)

Dr. Robert Mertzig: Modelling and design of high compression electron guns for EBIS/T charge breeders (Prof. Jürgen Faßbender)

Dr. Marcel Neubert: Die Rolle des Sauerstoffanteils in Titandioxid bei Tantal-Dotierung zur Verwendung als transparentes leitfähiges Oxid (Prof. Sibylle Gemming)

Dr. Gabi Steinbach: Ferromagnetic colloidal particles with anisotropic magnetization distribution: self-assembly and response to magnetic fields (Dr. Artur Erbe)

Dr. Daniel Robert Stephan: Inter-sublevel dynamics in single InAs/GaAs quantum dots probed by strong terahertz excitation (Prof. Manfred Helm)

Dr. Bezu Teschome: Functional DNA origami nanostructures for nanoelectronics (Prof. Jürgen Faßbender)

Dr. Tim Weichsel: Entwicklung und Charakterisierung einer Elektron-Zyklotron-Resonanz-Ionenquelle mit integriertem Sputtermagnetron für die Erzeugung intensiver Ströme einfach geladener Aluminiumionen (Prof. Jürgen Faßbender)

Dr. Oguz Yildirim: Effect of microstructure on the magnetic properties of transition metal implanted TiO2 (Prof. Jürgen Faßbender)

High-Magnetic Field Laboratory Dresden

Dr. Mahdiyeh Ghorbani Zavareh: Magnetic and thermal properties of rare-earth intermetallics (Prof. Joachim Wosnitza)

Dr. Richard Skrotzki: Supraleitung in Gallium-implementiertem Silizium (Prof. Joachim Wosnitza)

Institute of Radiopharmaceutical Cancer Research

Dr. Roberta Aliperta: Development of a bispecific antibody-based system for AML immunotherapy (Prof. Michael Bachmann)

Dr. Nicole Bechmann: Stickstoffmonoxid-freisetzende Cyclooxygenase-2-Inhibitoren zur Strahlensensibilisierung und Strahlenprotektion (Prof. Jörg Steinbach, Prof. Jens Pietzsch)

Dr. Feng Gao: Synthesis and radiolabeling of peptides for diagnostics and endoradionuclide therapy of melanoma (Prof. Jörg Steinbach, Dr. Hans-Jürgen Pietzsch)

Dr. Nadine Herwig: Der RAGE-Ligand S100A4: Regulation und Einfluss der intra- und extrazellulären Kompartimentierung bei der Metastasierung des malignen Melanoms (Prof. Jörg Steinbach, Prof. Jens Pietzsch)

Dr. Manuela Kuchar: Fluor-18-markierte Substrat-basierte Radiotracer zur in-vivo-Bildgebung der Lysyloxidase (Prof. Jörg Steinbach, Dr. Reik Löser)

Dr. Karina Pombo Garcia: Ultrasmall nanoparticles as multimodal agents for cancer imaging (Prof. Jörg Steinbach, Dr. Holger Stephan)

Dr. Susann Schröder: Entwicklung, Synthese und biologische Evaluierung von 18F-markierten Imidazopyridotriazinderivaten zur molekularen Bildgebung der Phosphodiesterase 2A im Gehirn mittels Positronen-Emissions-Tomographie (Prof. Peter Brust)

Dr. Martin Ulrich: Entwicklung und Charakterisierung von murinen Tumormodellen und präklinische theragnostische Untersuchungen zu Somatostatin-Rezeptor-vermittelten Therapien des metastasierenden Phäochromozytoms (Prof. Jens Pietzsch)

Dr. Sally Wagner: Entwicklung von Radioliganden zur bildgebenden Darstellung von Phosphodiesterase 10 (Prof. Peter Brust)

Institute of Radiooncology - OncoRay

Dr. Anna Bandurska-Luque: (18F)FMISO-PET/CT-basierte Hypoxie in Lymphknotenmetastasen von Kopf-Hals-Tumoren: Ausgangsstatus, Reoxygenierungsverlauf und prognostischer Wert (Prof. Michael Baumann)

Dr. Katharina Beyer: Etablierung der Magnetorelaxometrie kalibrierten µ-Computertomographie zur Darstellung und Quantifizierung von magnetischen Nanopatikeln am Mausmodell (Prof. Mechthild Krause)

Dr. Christian Golnik: Treatment verification in proton therapy based on the detection of prompt gamma-rays (Prof. Wolfgang Enghardt)

Dr. Fernando Hueso González: Nuclear methods for real-time range verification in proton therapy based on prompt gamma-ray imaging (Prof. Wolfgang Enghardt)

Dr. Annika Jakobi: Evaluation of proton treatment strategies for head and neck cancer and lung cancer based on treatment planning studies (Prof. Wolfgang Enghardt)

Dr. Daniel Kloppert: Rezidive nach Strahlentherapie beim abenoidzystischen Karzinom (Prof. Mechthild Krause)

Dr. Laura Kuder: Vergleich manueller und halb-automatischer Methoden der Zielvolumendefinition für die stereotaktische Strahlentherapie von Patienten mit malignen pulmonalen Läsionen in der 3D-FDG-PET, der 4D-FDG-PET und der 4D-CT (Prof. Esther Troost)

Dr. Lucas Persson: Novel in-treatment dose verification methods for adaptive radiotherapy (Prof. Esther Troost)

Dr. Anne Steglich: Die Rolle von α Integrinen für die zelluläre Strahlenempfindlichkeit dreidimensional wachsender humaner Plattenepithelkarzinomzellen des Kopf- und Halsbereiches (Prof. Nils Cordes)

Dr. Christl Thiele: Auswirkungen einer Tatintherapie auf rezidivfreies und Gesamtüberleben sowie die Ausprägung von akuten und chronischen Nebenwirkungen im Rahmen der Strahlentherapie von Kopf-Hals-Malignomen (Prof. Mechthild Krause)

Dr. Prasad Thute: Development of a small animal image-guided radiation therapy device for precise irradiation of small animal tumors (Prof. Wolfgang Enghardt)

Dr. Elisa Zienert: Untersuchungen zur Rolle von LIM Proteinen für die Strahlenresistenz humaner Tumorzellen (Prof. Wolfgang Enghardt)

Institut of Ressource Ecology

Dr. Isabell Dreißig: Untersuchung von Pseudokolloiden tetravalenter Actiniden mit laserinduzierter Breakdown-Detektion und weiteren Kolloidcharakterisierungsmethoden (Dr. Harald Zänker)

Dr. Björn Drobot: Entwicklung und Validierung mathematischer Methoden zur Auswertung spektroskopischer Daten der Uranyl(VI)-Hydrolyse (Dr. Johannes Raff)

Dr. Katja Heine: Bindung von Aktinoiden und Lanthanoiden an funktionalisierten Proteinen und menschlichen Biofluiden (Dr. Harald Zänker)

Dr. Muhammad Obeid: Assesment of low-dose radiotoxicity in microorganisms and higher organisms (Prof. Karim Fahmy)

Dr. Constanze Richter: Sorption of environmentally relevant radionuclides (U(VI), Np(V)) and lanthanides (Nd(III)) on feldspar and mica (Dr. Vinzenz Brendler)

Department Communication and Media

Dr. Matthias Streller: The educational effects of pre- and post-work in out-of-school laboratories (Prof. Gesche Pospiech - TU Dresden / Prof. Avi Hofstein - Weizmann Institute of Science / Prof. Jürgen Faßbender)

Online Annual Report 2016: HZDR Facts and Figures

(as of December 31, 2016)

Total annual budget including investments	approx. 131 million Euros
of that, external revenues	approx. 21 million Euros

Number of employees	1.128
Number of PhD students	157
Number of trainees	39

Professors	
Number of joint appointments at Saxon universities	14
Adjunct and honorary professorships	7

Junior Research Groups	8

ERC Starting Grants	2

Publications	
Articles (ISI / Scopus cited)	562
Other cited publications	26
Books	9
Doctoral theses	51

Large-scale scientific facilities (Helmholtz performance category II)	
Ion Beam Center IBC	13.251 hours
ELBE - Center for High-Power Radiation Sources	3.825 hours
Dresden High Magnetic Field Laboratory HLD	98 measurement campaigns / 151 measurement weeks / 6.259 applied magnetic pulses

Science and technology transfer	
Applications by priority	12

Students at Delta X School Lab	approx. 3.000

Dr. Bohnet, Christine | 20.09.2017