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Read more on page 2

Dear readers,

we are making concentrated progress toward reaching the strategic goals of GSI and FAIR. Alongside the scientific appeal of GSI and FAIR and the upgrades of GSI accelerators, the FAIR construction project has made crucial progress. The northern section of the construction site has developed very well, and the next big step will be the call for tenders for the southern section.

Many components for the facility are already in production or ready to undertake thorough tests of their functions. For this purpose, we have agreed on numerous cooperations with our partners in and out of the country.

The existing accelerator facility has been significantly upgraded and improved for its future role as a pre-accelerator for FAIR over the past two years. The facility's next operation in the framework of scientific experiments is now planned for the upcoming year.

Research, meanwhile, continues to deliver excellent results, as many high-ranking publications show. As always, we'd like to inform you about them in this magazine.

Enjoy reading.

Paolo Giubellino
Scientific Managing Director
of FAIR and GSI
on behalf of the Management Board

ESA and FAIR form partnership to research cosmic radiation

One of the key questions that need to be addressed regarding the future of human spaceflight as well as robotic exploration programs is how cosmic radiation affects human beings, electronics, and materials. The detailed investigation of this topic is one of the main tasks that must be accomplished in order to provide astronauts and space systems with effective protection. To achieve this goal, the European Space Agency (ESA) will be cooperating closely in the future with the international accelerator center FAIR, which is currently being built at GSI. The two partners signed a corresponding cooperation agreement at the GSI and FAIR campus in Darmstadt.

By signing the agreement, ESA Director General Professor Johann-Dietrich Wörner and the FAIR Management Board, consisting of the Scientific Managing Director Professor Paolo Giubellino, the Administrative Managing Director Ursula Weyrich, and the Technical Managing Director Jörg Blaurock, sealed an international partnership that will open up far-reaching opportunities for new scientific findings. For example, radiation is a showstopper for human missions to the Moon and Mars as well as for scientific missions to the depths of space. Also present was ESA astronaut Thomas Reiter, one of the initiators of the cooperation.

Unique research opportunities

"The partnership between FAIR and ESA will open up unique opportunities for carrying out outstanding research in the area of cosmic radiation and its effects," said Professor Paolo Giubellino. "FAIR will be an institute that is unique in the world. It will enable researchers to reproduce the diversity of the universe in the laboratory, so to speak, in order to investigate fundamental questions such as how the chemical elements came into existence in the cosmos, gain knowledge about the effect of radiation on cells and solid objects, and forge ahead with practical applications in areas such as biophysics and materials research. We are eagerly looking forward to closer cooperation with the ESA."

Professor Johann-Dietrich Wörner also emphasized the significance of the new partnership between the two international institutes: „GSI is the only facility

Outside of the Earth's protective atmosphere and its magnetic field, astronauts and satellites are exposed to cosmic radiation. In the picture the Earth observation satellite Sentinel 3.

From left: Technical Managing Director of GSI/FAIR Jörg Blaurock, Scientific Managing Director of GSI/FAIR Professor Paolo Giubellino, ESA Director General Professor Johann-Dietrich Wörner, Administrative Managing Director of GSI/FAIR Ursula Weyrich, ESA astronaut Thomas Reiter.

in Europe capable of simulating high-energy heavy nuclei occurring in cosmic radiation. With FAIR, experiments with an even wider range of particle energies and intensities will soon be possible. This reproduction of the cosmic radiation environment can support us in many areas, from materials research for satellite missions to radiobiology, which deals with the effects of cosmic radiation on the human organism, and is an important preparation for long-term astronautical missions to the moon and beyond."

When they move beyond the Earth's protective atmosphere and its magnetic field, astronauts, satellites, and space probes are exposed to cosmic rays. An essential component of cosmic rays are fast particles that are ejected into space during stellar explosions or emitted by the sun and by distant galaxies. What effects would radiation have on human beings and spacecraft during a long space journey, for example to Mars? What would happen to the sensitive electronics on board? What materials, in which thicknesses, would be suitable protective shields to mitigate these effects? Can radiation-resistant materials and electronic components be developed in a targeted manner? These are some of the basic questions that are crucial to the implementation of such space missions. The aim is to provide the best possible conditions for human beings and materials in space and to minimize the risks to health.

In the future, researchers at the FAIR accelerator facility will be able to generate the kinds of radiation that exist in space and make them available to scientists for their experiments. For example, researchers will be able to investigate how cells and human DNA are altered or damaged by exposure to cosmic radiation and how well microchips stand up to the extreme conditions in space.

The central points of the cooperation agreement between ESA and FAIR include the research fields of radiation biology, electronic components, materials research, shielding materials, and instrument calibration. The research will be conducted at the future FAIR facility as well as the existing accelerator facilities at GSI, which are currently being improved through major upgrading measures and prepared for their future use as preaccelerators for FAIR. The two partners have also agreed to cooperate on technology and software developments and on additional joint activities in areas such as innovation management.

Particle accelerator will enable broad range of radiation research

The new partnership is building on a very successful and reliable foundation of cooperation that has been formed between ESA and GSI over many years in several research projects. For example, the IBER (Investigations into Biological Effects of Radiation) research project has been running since 2008 and is currently entering a new round with the allocation of beam time. The project enables research groups to investigate the biological effects of space radiation at the existing accelerator facilities of GSI.

The GSI accelerator facility is the only one in Europe that can generate all of the ion beams that occur in our solar system, which range from the lightest one, hydrogen, to the heaviest, uranium. The research opportunities will be expanded even further by the future FAIR accelerator center. Thanks to its centerpiece, the ring accelerator SIS100 with a circumference of 1,100 meters, FAIR will enable researchers to conduct experiments with an even wider spectrum of particle energies and intensities, and to simulate the composition of cosmic radiation with a precision that no other accelerator facility will be able to match.

The fundamental research issues are being investigated against a background of complex relationships. There are many different kinds of cosmic rays, and they can have very different effects on spacecraft and their occupants, depending on the kinds of particles, the particles' energies, and the duration of the exposure. In addition, cosmic rays' interactions with matter, such as their impact on a protective shield, produce secondary cosmic rays that have very different effects. These secondary rays can do even more damage to biological tissue and sensitive electronics than the original primary cosmic radiation.

Professor Paolo Giubellino, Scientific Managing Director of FAIR and GSI (left), and ESA Director General Professor Johann-Dietrich Wörner present the cooperation agreement.

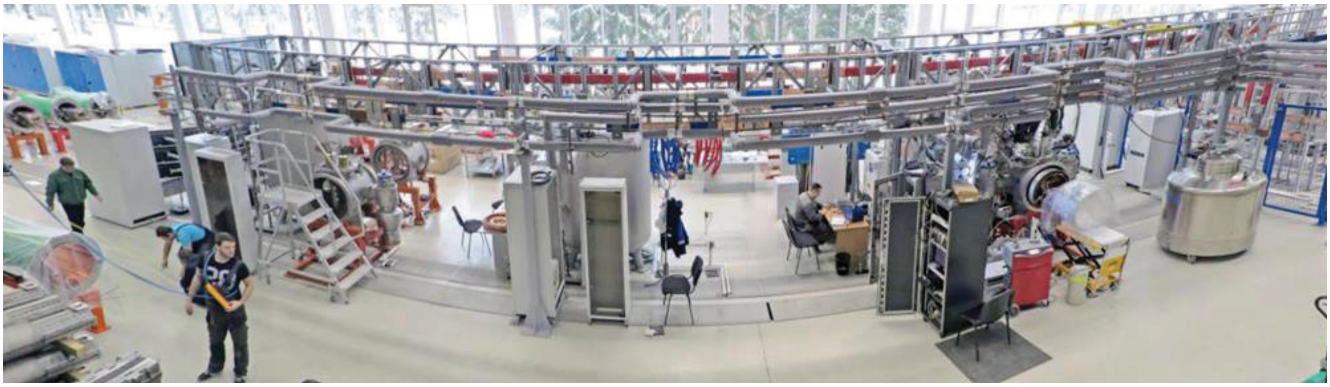
Optimized instruments, advantages for mission planning

The objective of the new partnership is to precisely identify these complex relationships and investigate them in even greater depth. For example, new findings could help scientists adapt sensitive instruments specifically for utilization in space. Such research projects are also of interest to the ESA´s European Space Operations Centre ESOC in Darmstadt. This is where satellite missions are controlled and their trajectories are calculated. Detailed knowledge of the radiation sources and effects is helpful for mission planning. It can help researchers select flight variants that will minimize the total radiation load. Both FAIR and ESOC very much look forward to the opportunities of enhanced collaboration between these two Darmstadt-based institutions, which contribute to strengthen Darmstadt as an internationally established City of Science. ■

Physics for breakfast — Saturday Morning Physics at FAIR and GSI

It is a success story with tradition and at the same time an anniversary: For the 20th time 260 high-school students from all over the state of Hesse had the opportunity to gain an insight into current physical research at FAIR and GSI. During tours of the research facilities they explored the accelerators and experiments on the GSI and FAIR campus and learned about the construction of the international FAIR facility. At the beginning they joined for a traditional small breakfast. „Saturday Morning Physics" is a project of the physics department of the Technical University of Darmstadt. The series of lectures is held annually and aims to increase the interest of young people in physics. In lectures and experiments on six consecutive Saturdays the high-school students learn about the latest developments in physical research at the university. Those who take part in all six courses receive the „Saturday Morning Physics" diploma as a reward. The visit to FAIR and GSI takes place as an excursion within the series. GSI has been one of the sponsors and supporters of this project since the start. ■

Cryogenic testing of magnets: First quadrupole units for FAIR ring accelerator tested



Series testing facility at the Joint Institute for Nuclear Research (JINR) in Dubna, Russia, for superconducting magnets of FAIR and NICA.

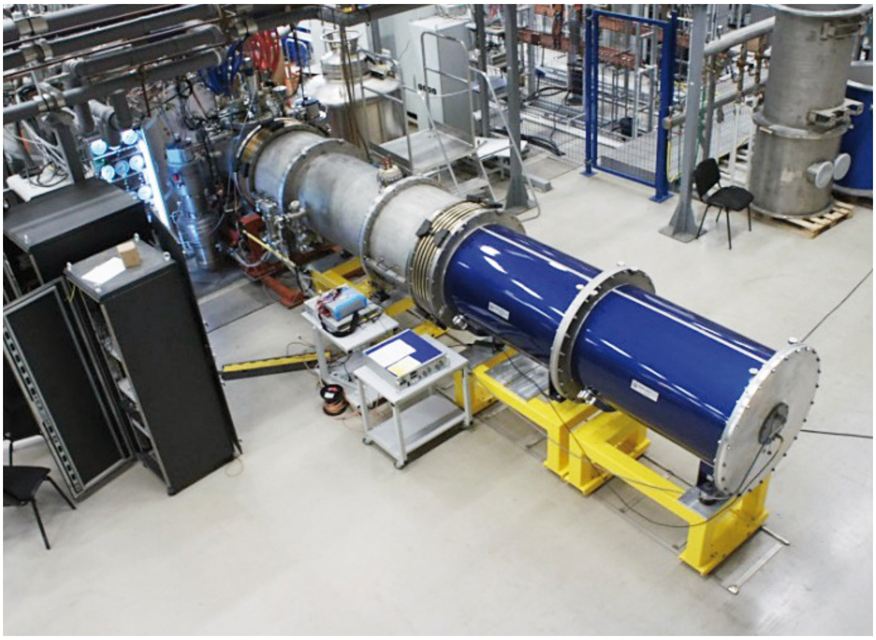
Hundreds of powerful magnets will be needed to guide particles in a precise beam at nearly the speed of light at the future accelerator center FAIR. Widely varied types of magnets and magnet systems are used for this purpose. They include the quadrupole magnet units that will be used in the large SIS100 ring accelerator. These units are being manufactured and tested by Russia and represent an important non-cash contribution to the FAIR project. The two first of series (FoS) quadrupole units were manufactured in 2017, and at the end of the year they were successfully subjected to cryogenic tests at temperatures near absolute zero. The tests are another important step in the development and construction of the SIS100.

The quadrupole units, weighing tons, consist of a superconducting quadrupole magnet that is combined in a variety of arrangements with superconducting sextupole and steering magnets. Unlike conventional copper cables, superconductors enable electricity to flow through them without any resistance. In order to achieve superconductivity, the units are cooled down to 4.5 Kelvin (i.e. 4.5 degrees Celsius above absolute zero, which is about minus 273 degrees Celsius) during operation.

The quadrupole magnets worked flawlessly during fast-pulsed operation in the performance tests in Russia at 23,000 amperes per second, the magnets surpassed the intended maximum operating current of about 12,000 amperes. Initial evaluations of the measured magnetic fields indicate that the units are of a sufficiently high quality within the range of the defined requirements.

With acceptance and delivery of the FoS units the clearance of series production is scheduled to be approved in the near future. GSI will subject the two units to an initial integration test, in which they and other installations will be mounted onto a carrier system.

Over the past four years, GSI and the Joint Institute for Nuclear Research (JINR) have built a high-performance testing facility in Dubna, Russia, to conduct cryogenic testing of the units from the series. It tests superconducting magnets for the two future accelerator centers FAIR and NICA (Nuclotron-based Ion Collider fAcility), which are currently being built at GSI in Darmstadt and at JINR in Dubna. The facility will be used jointly to test magnets for the NICA project and the future SIS100 accelerator at FAIR. ■



The first SIS100 quadrupole units during cryogenic testing at the new testing facility at the Joint Institute for Nuclear Research (JINR) in Dubna, Russia. Due to the special design of the quadrupole units, a special test cooling device, the test cryostat (blue), had to be developed and manufactured.

Transformer station goes into operation at the FAIR construction site

Transformer station North on the FAIR construction site.

This year the first of two transformer stations went into operation at the construction site of the future FAIR accelerator facility. It was the first system at FAIR to go into operation. The station provides the energy supply to the existing SIS18 ring accelerator and will also do so for the future SIS100 ring accelerator.

The transformers were delivered to the FAIR construction site in the fall of 2017. They were then installed and have been put into operation as planned.

Two transformers at FAIR's North Transformer Station were switched through to GSI in order to supply parts of the facility with electricity. Until then, GSI had been supplied with power exclusively through the transformer station at Leonhardstanne. The new transformers improve the performance of the pulse load supply, which will be needed in the future for the operation of the SIS18 and SIS100 particle accelerators. The new transformers convert the 110 kilovolts high-voltage electricity that arrives at GSI and FAIR through underground high-voltage cables to 20 kilovolts so that the current reaches the various consumers on the campus in line with their needs.

The second transformer station FAIR South also started operation in July 2018 and supplies energy for the FAIR construction site. ■

Visit to Azerbaijan: Scientific cooperation to be intensified

Perspectives and opportunities for future cooperation were the focus of a visit by Professor Paolo Giubellino, Scientific Director of FAIR and GSI, to the Republic of Azerbaijan. The aim is to intensify the scientific exchange between German and Azerbaijani researchers. In order to promote scientific and technological cooperation between FAIR and Azerbaijani research institutions, a "Memorandum of Understanding" (MoU) has been signed in the capital Baku on the Caspian Sea.

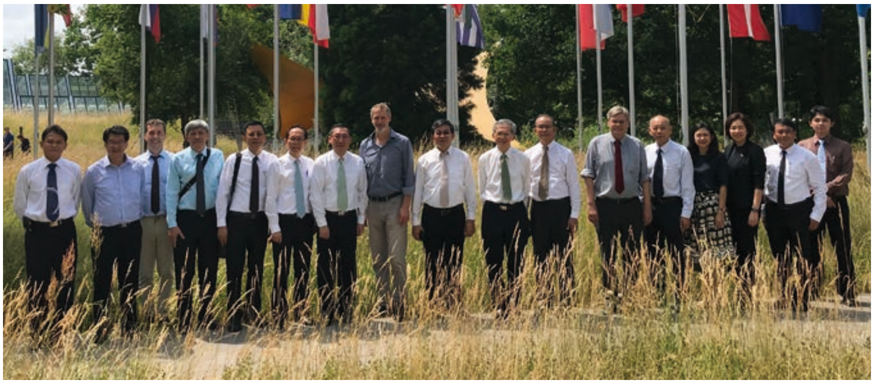
Paolo Giubellino held very productive discussions with, among others, Minister Ramin Guluzade of the Ministry of Transport, Communication and High Technologies (MTCHT) of the Republic of Azerbaijan and Professor Abel Maharramov, Rector of the Baku State University (BSU), one of the largest universities in the country. During his visit, he also learned about the current research and infrastructure in Azerbaijan.

In a ceremonial setting the Memorandum of Understanding was signed in Baku.

The Memorandum of Understanding provides for scientific and technological cooperation and joint projects between scientists from BSU, MTCHT and FAIR. Among other things, the MoU encompasses a variety of opportunities for collaboration and information sharing, such as seminars, symposia, and science meetings. The memorandum will also promote cooperation by means of joint research projects and exchange activities between professors and scientists — particularly young scientists, and university students. The activities are coordinated by Professor Paolo Giubellino and Dr. Anar Rustamov, Deputy Director at the Institute for Physical Problems of BSU.

University Rector Abel Maharramov emphasized the importance of cooperation in science and technology to strengthen links between the scientific communities of both countries. Minister Ramin Guluzade moreover announced that a roadmap for Azerbaijan's possible accession to the international FAIR GmbH would be developed. ■

Delegation from Thailand obtains information about FAIR and GSI



Group picture of delegation from Thailand.

A high-ranking delegation from Thailand consisting of 15 participants visited the FAIR and GSI facilities this summer. To the group, among others, belonged Professor Soranit Siltharm, Permanent Secretary to the Ministry of Science and Technology, and Professor Sarawut Sujitjorn, Director of the Synchrotron Light Research Institute (SLRI) in Nakhon Ratchasima, Thailand.

Professor Paolo Giubellino, Scientific Managing Director of FAIR and GSI, welcomed the participants and informed them about the research activities. Subsequently, Jörg Blaurock, Technical Managing Director of FAIR and GSI, gave an overview about the FAIR project and the advancements of the construction, which was enhanced by a bus tour to the construction site.

Furthermore, Dr. Michael Schulz and Dr. Pradeep Ghosh reported on the biophysics research and the student program GET_involved. In a guided tour lead by Dr. Ingo Peter and Dr. Klaus-Dieter Groß, the guests from Thailand visited the existing research facility: In the Main Control Room they were able to witness the commissioning of the accelerator. Also they visited the experimental storage ring ESR, the therapy facility for the treatment of tumors with carbon ions, as well as the large-scale detector HADES. In the energy-efficient high-performance computer center Green IT Cube they got to know more about the data processing of FAIR and GSI. ■

„I couldn't have wished for a better internship" — Lilly Schönherr receives award for internship report

For her outstanding internship report Lilly Schönherr received an award by the "Arbeitskreis Schule Wirtschaft Osthessen". Lilly Schönherr studies in the ninth grade of the Geschwister-Scholl-Schule, a secondary school in Rodgau. She completed her two-weeks of company placement in the research department "Atomic Physics" at GSI. With her award for the second-best internship report in the school level "secondary school" she is also qualified for the next evaluation level (Osthessen). The award was bestowed in June 2018 at the Sparkasse Langen-Seligenstatt. Next to the awardees also the mentoring teachers as well as the internship companies received a certificate of appreciation.

The internship of Lilly Schönherr was supervised by Dr. Wolfgang Quint and his colleagues from GSI's atomic physics department, especially Nils Stallkamp und Davide Racano. Mainly she worked at the experiments ARTEMIS and HILITE of the ion trap HITRAP, which is connected to the experimental storage ring ESR. Among other things, she built in detectors, tested vacuum components for her leak tightness and equipped a thermic shield with a multi-layered foil during her internship. Also milling in the workshop, the work with electronics and the design of mechanical components with a CAD system was part of her work. Lilly wants to become a physicist, and her conclusion in the internship report is: "I couldn't have wished for a better internship."

Milling of components in the workshop was also part of the work during Lilly Schönherr's internship.

The "Arbeitskreis Schule Wirtschaft Osthessen", a task force to bring together schools and industry in the eastern part of the State of Hesse, consists of the six sub-divisions in Schlüchtern, Gelnhausen, Hanau, the city of Offenbach, and the districts of Offenbach East and West. The competition is held in six school types. A jury of regional representatives of schools and companies evaluates the reports taking into account their formal structure, their content, their layout and originality and the overall impression. The winners of all school types receive sponsored prizes and an award certificate. ■

"FAIR is a reason to be here" — Dr. Alexandre Obertelli receives Humboldt Professorship at TU Darmstadt

Dr. Alexandre Obertelli is the first Humboldt Professor in Hessen.

The Technical University Darmstadt is awarded an Alexander von Humboldt Professorship for the first time; it is also the first one in the state of Hesse. In his role as a Humboldt Professor at TU Darmstadt, Dr. Alexandre Obertelli is set to expand the field of physics of rare isotopes into a world-leading research location. He will also be involved in the development of the FAIR particle accelerator facility at GSI, which is currently under construction. The nuclear physicist, nominated by the TU Darmstadt, is one of five scientists from abroad who have been selected this year for Germany's most highly endowed international research award.

"The international FAIR accelerator facility with its unique research opportunities for scientists from all over the world is one of the reasons for me to come to TU Darmstadt," says Obertelli. "I look forward to working at FAIR and contributing to its scientific output by my research. This will also enhance the cooperation between TU Darmstadt and FAIR, and will further establish the 'City of Science' Darmstadt as a world-class research location."

The Alexander von Humboldt Professorship, which is endowed with up to five million euros each, is awarded to the world's leading researchers of all disciplines who have so far worked in another country. They are to conduct forward-looking research at German universities in the long term. The award is granted by the Alexander von Humboldt Foundation and financed by the Federal Ministry of Education and Research.

The Humboldt Professorship enables German universities to offer top international researchers competitive general conditions for research and to sharpen their own international profiles in the global research market at the same time. The award is granted on the precondition that the new Humboldt Professors are given long-term prospects for their research in Germany. To date, a total of 68 researchers, including twelve women, have been appointed to a Humboldt Professorship, facilitating their move to Germany.

Born in France, Alexandre Obertelli previously worked at the Institute of Research into the Fundamental Laws of the Universe (IRFU) at the Commissariat à l'énergie atomique et aux énergies alternatives (CEA) in Paris-Saclay, France, from 2006 as a Senior Researcher. In between times, he conducted research in the National Superconducting Cyclotron Laboratory (NSCL) at Michigan State University, USA, and at the RIKEN Research Institute in Japan. His work has gained him numerous grants, including an ERC Starting Grant and an ERC Consolidator Grant from the European Research Council. He is a member of various program advisory boards at renowned research institutions like CERN in Switzerland as well as the Research Center for Nuclear Physics (RCPN) and RIKEN in Japan. In the context of FAIR and GSI Obertelli already has a number of tangible project proposals for the enhancement of the scientific coverage of the R3B and HISPEC experiments which belong to NUSTAR (Nuclear Structure, Astrophysics and Reactions), one of the four experimental pillars of FAIR.

How were chemical elements — the building blocks of our world — originally formed? What are the processes behind their formation? In the context of these fundamental questions in nuclear and atomic physics Alexandre Obertelli studies so-called exotic nuclei, atomic nuclei with a comparatively disproportionate number of protons or neutrons. They have barely been researched so far. A deeper understanding of their properties could provide insights into the development of elements in the universe because neutron-rich atomic nuclei play a central role in the formation of heavy elements. In this connection, Obertelli led experimental investigations on the reactions and structures of exotic nuclei which have now become a benchmark in nuclear physics. He has also developed and implemented spectroscopic measuring methods for characterising extremely neutron-rich isotopes, whose further developments shall be implemented at FAIR. In the framework of his Humboldt Professorship he plans new projects for an enhancement of the R3B experiment to facilitate new research opportunities with exotic ions beams at FAIR, e.g. the study of neutron-rich hyper nuclei or the exploration of properties of neutron-rich nuclear matter as it occurs in neutron stars. ■

Summer Student Program at GSI and FAIR took place for the 38th time

Participants of the Summer Student Program.

36 students from 24 countries took part in this year's Summer Student Program at GSI and FAIR. During their eight-weeks stay on the campus they participated actively in GSI and FAIR science projects, got to know the experiments and the research areas and got involved in the everyday working life at an accelerator institute.

From plasma physics to tumor therapy and atomic physics: Every summer student got the chance to work on his own research project within the current GSI and FAIR experiments.

The main focus were developments and tests of technical and experimental components for the accelerator facility FAIR, which is being built at GSI, and its future experiments. Apart from the scientific program there were also social events planned like a barbecue party, a football match or trips to the region for networking and international exchange. In public lectures, which are part of the program, the summer students learned about GSI and FAIR research and scientific results.

For many of the students, who come mainly from European but also from more distant countries in Asia or Central America, the Summer Student Program is the first step to a master or PhD thesis at GSI and FAIR. The Summer Student Program, which took place for the 38th time, is organized together with the graduate school HGS-HIRe. ■

Masterclass 2018 — Particle physicist for a day

This year the 8th International Masterclass took place at FAIR and GSI. 20 high-school students were invited to become a scientist for a day and analyze data from the ALICE experiment at the LHC accelerator at CERN in Geneva. GSI has had a major part in the construction and the scientific program of ALICE from the beginning.

The participants were asked to evaluate and interpret data of the ALICE experiment. Under professional supervision of scientists they autonomously analyzed recent data recorded in proton-proton and lead collisions. In the lead collisions a so-called quark-gluon plasma is generated – a state of matter which existed in the universe shortly after the big bang. This plasma undergoes a phase transition back to normal matter in fractions of seconds. The particles produced in the process can give insight into the properties of the quark-gluon plasma.

In two introductory talks about quark-gluon plasma and the examination of heavy ion collisions at the ALICE experiment the pupils were informed about the analysis. Furthermore they visited the large-scale experiment HADES, one of the current experiments at the GSI accelerator facility that will also become a part of FAIR. Afterwards they started the data analysis.

The 20 participants of the Masterclass 2018 analyzed original data from the ALICE experiment.

The basic idea of the program is to allow the students to work in the same fashion as the scientists. This includes having a videoconference at the end of the day. In a conference connection with groups from the universities in Frankfurt, Münster, and Padua (Italy) as well as CERN they presented and discussed their results.

This year, 215 universities and research institutes from 52 countries participate in the International Masterclasses. They are organized by the International Particle Physics Outreach Group (IPPOG). All events in Germany are held in cooperation with the „Netzwerk Teilchenwelt", a nationwide network committed to the communication of particle physics to youngsters and teachers. They aim to make particle physics accessible to a broader public. As of late, GSI as a location is also a part of "Netzwerk Teilchenwelt". ■

Magnet tests for FAIR: GSI and CERN conclude cooperation agreement

Many of the key components for the future particle accelerator facility FAIR are currently under development or in production. However, production isn't the only decisive step, because the testing of the individual parts' quality is also crucial. The European Organization for Nuclear Research (CERN) in Switzerland and GSI, where FAIR is currently being built, have now concluded a cooperation agreement for the reliable testing of magnets weighing more than 50 tons each and destined for use in the Superconducting Fragment Separator (Super-FRS), which will be part of the FAIR facility.

As part of the collaboration, the partners have created a test facility containing three magnet test rigs. The first tests are scheduled to begin in first half of the year 2018. The facility will conduct intense endurance tests of multiplets, which are superconducting magnet units with corrective lenses, and then examine if they behave flawlessly in accordance with high quality standards during operation. Unlike the usual copper cables, superconducting systems don't pose any resistance to electric currents. To achieve superconductivity, the units are cooled to around minus 270 degrees Celsius during operation.

The multiplets, which weigh up to 60 tons each, will later be used for beam correction in the Super-FRS at FAIR to achieve a high-precision particle beam. This part of the future accelerator center FAIR will be used for experiments on the fundamental structure of extremely rare exotic nuclei. For these experiments, ions of the heaviest elements will be shot at a target, where they will shatter upon impact. The resulting fragments will include exotic nuclei that the Super-FRS can supply to scientists for their experiments. The Super-FRS will enable researchers to produce exotic nuclei up to uranium at relativistic energies and separate them into pure isotopes. Because this process lasts for only a few hundred nanoseconds, it provides researchers access to very short-lived nuclei.

The multiplets, which were manufactured in Genoa, Italy, are an important in-kind contribution from GSI to the FAIR project, as is the subsequent testing process. GSI is the German shareholder of the international FAIR GmbH. All of the superconducting magnets that will be needed for the Super-FRS will be tested in the new test facility at CERN. The magnets will initially consist of a total of 33 multiplet units, which will be followed by 24 superconducting dipole magnets that will be needed for deflecting the particle beam.

The test facility for magnets at CERN will be used to test multiplets for the Super-FRS.

French High-Commissioner for Atomic Energy Yves Bréchet visits FAIR and GSI

Professor Yves Bréchet, the High-Commissioner for Atomic Energy, visited the FAIR and GSI research facilities in this year. In an introductory talk he was informed by Professor Paolo Giubellino, Scientific Managing Director of FAIR and GSI, about the on-going research activities at the existing facility and the planning of the FAIR project.

Subsequently, the Technical Managing Director of FAIR and GSI, Jörg Blaurock, showed him the current progress of the SIS100 tunnel construction and the further construction activities in a bus tour of the FAIR construction site. In a guided tour through the existing accelerator facility he visited the materials

Professor Christina Trautmann, head of the research department for materials science, showed her experimental site to Professor Bréchet and explained the research activities in materials science.

research, the experimental site for the discovery of superheavy elements SHIP, the PHELIX laser, the therapy site for tumor treatments with carbon ions, the FAIR storage ring CRYRING and also the large-scale experiment R3B, which houses a French contribution to FAIR, the so-called GLAD magnet.

Yves Bréchet is the Government Scientific Advisor for the missions of the French Atomic Energy and Alternative Energies Commission (CEA, Commissariat à l'énergie atomique et aux énergies alternatives). The governmental institution is subordinate to the French ministries for research, energy, armed forces, and industry. Together with the French National Center for Scientific Research (Centre national de la recherche scientifique, CNRS) the CEA holds half of the French shares of FAIR. ■

GSI and FAIR present themselves at "Wissenswerte" in Darmstadt

GSI and FAIR presented cutting-edge research in the area of particle acceleration physics at the "Wissenswerte" (Worth Knowing) dialogue-oriented forum, which was held at the Darmstadtium congress center in Darmstadt some time ago. About 400 specialized journalists, science communicators, and researchers attended the forum, which is Germany's most important conference for science journalism. GSI and FAIR representatives made specialized contributions to the conference program, hosted a major excursion, and staffed an exhibition stand of their own. Not only the specialists but also the general public had the opportunity to visit the GSI and FAIR stand on the second afternoon of the forum.

Among other things, GSI and FAIR presented the research opportunities that will be offered at the FAIR particle accelerator center now being constructed at GSI, as well as the construction project itself. The highlights of the presentation included the best-known results of the scientific research at GSI, such as the development of an innovative cancer therapy using ions and the discovery of six new chemical elements in the periodic table. Visitors to the stand were also able to simulate the creation of an element in a large-format model — and thus to understand how the new element called "Darmstadtium" was born at GSI. The venue of the "Wissenswerte" forum was named the Darmstadtium after this element.

GSI and FAIR also played a major role in the conference program, which gave the participating specialists from all over Germany insights into the latest findings of current scientific research. In a discussion, physicist Dr. Ingo Peter presented the topic "The Universe in the Laboratory — Creating Cosmic Matter in Accelerators." At the Forum for Young Researchers, the leading young researcher Professor Tetyana Galatyuk offered insights into the scientific work she is doing at the large-scale detector HADES at GSI. Finally, on the third day of the event GSI and FAIR hosted an excursion. It included a walking tour of the research campus and a bus tour of the 20-hectare construction site of the new FAIR accelerator facility. This is one of the world's biggest construction projects for a basic research facility, and it is currently one of the most exciting construction sites in the region. In the future, about 3,000 scientists from all over the world will conduct cutting-edge experiments at FAIR in order to gain new fundamental knowledge about the structure of matter and the evolution of the universe. ■

At the exhibiton stand visitors were able to simulate the production of an element.

First event at GSI and FAIR in the context of Netzwerk Teilchenwelt

This year, the first event in the context of Netzwerk Teilchenwelt took place at GSI and FAIR. About 20 high school students of Schuldorf Bergstraße got to know the basics of heavy ion and particle physics in a teaching unit and afterwards took a one-day trip to GSI and FAIR. There they visited the research facility and analyzed real experiment data. The membership of GSI in Netzwerk Teilchenwelt opens up new options in promotion of young researchers.

Schuldorf Bergstraße visiting the GSI and FAIR campus.

GSI is part of the Netzwerk Teilchenwelt since 2017. The network supports particle physics institutes in Germany to offer workshops on astrophysics and particle physics for young people and teachers at schools, school labs or museums. Now the first two-day workshop took place at the campus of GSI and FAIR and at Schuldorf Bergstraße. One GSI scientist and two GSI PhD students, who are active in Netzwerk Teilchenwelt, managed the event with support of the teacher. The students got an impression of the principles of research at accelerator experiments by working with real science data. They analyzed data of the CERN experiment ALICE where GSI researchers are involved. On the tour through the facility the students saw particle accelerators and large detectors.

For eight years the International Masterclass takes place at GSI and FAIR, where students analyze real experiment data as well. With the help of Netzwerk Teilchenwelt the program is supposed to be expanded. More events for students and teachers are planned. ■

More than 40 girls learn about science and technology during Girls'Day

Earlier this year a total of 43 schoolgirls — an unprecedented number — from grades 5 through 9 had the opportunity to find out about the work at GSI and FAIR during Girls'Day. They took advantage of this future-oriented day to gain an insight into the many activities that are pursued at an international research institution, especially in professions where women have seldom been represented so far.

For the participants, Girls'Day began with a welcoming address by Dorothee Sommer, head of the Human Resources department, and Dr. Birgit Kindler as a representative of the equal opportunities committee. This was followed by a tour of the particle accelerator and experiment facilities on the research campus.

After that, the girls could gain practical experiences in various technical and scientific working areas at workshops, technical laboratories, and research departments. Many departments had prepared for the girls' visit by creating a special program, and they provided plenty of support for their young visitors. For example, the girls could try their hand in the mechanical workshops, soldered electronics and worked with concrete. They were also given a tour of the construction site of the future FAIR particle accelerator, which will be unequaled anywhere else in the world. After all this, the girls could look back on an exciting day during which they had achieved many practical results. For example, they had produced candle holders, milled buttons for themselves, made ice cream with liquid nitrogen, controlled bikes for their safety equipment or plated components with a metallic layer in the electroplating shop.

Girls'Day is a day of action all over Germany. On this day, businesses, factories, and universities all over Germany open their doors to schoolgirls from grade 5 and above. There the girls learn about courses of study and professions that offer traineeships in the areas of IT, the skilled trades, the natural sciences, and technology — areas where women have seldom been active in the past. ■

Start-up Class 5 Photonics zweifach ausgezeichnet

Class 5 Photonics, a spin-off from Helmholtz-Institut Jena, a branch of GSI, and from Deutsches Elektronen-Synchrotron DESY specialized in high-performance laser technology, is the proud winner of the PRISM AWARDS 2018 in the category lasers. Their laser system SuperNova OPCPA took the trophy home. Furthermore, SuperNova OPCPA is the Gold Winner of the Laser Focus World Innovators Award 2018 in the laser category. The award recognizes companies that have made major contributions to advancing the field of optics and photonics through recently launched products or services and is awarded yearly during the CLEO conference and tradeshow in San Jose, California

“We are delighted to win this prestigious award and being recognized as the premier laser technology partner for the most advanced R&D labs and institutions worldwide,” said Class 5 Photonics CEO and co-founder Robert Riedel. “With our products we aim to enable cutting-edge research to gain new insights in processes, building blocks and interactions in physics, chemistry and bio sciences.”

Class 5 Photonics‘ Klaus Schmidt, Robert Riedel, Michael Schulz and Ivanka Grguras (from left to right) at the award ceremony in San Francisco.

The PRISM AWARDS are the premier worldwide event in the photonics industry and awarded annually during the SPIE Photonics West conference and tradeshow in San Francisco. More than 150 applicants entered the competition in ten categories this year. With its high-performance laser SuperNova OPCPA Class 5 Photonics convinced the jury.

From left: Klaus Schmidt, Robert Riedel and Michael Schulz from Class 5 Photonics with Jeff Nichols from Laser Focus World.

The spin-off company was founded in 2014 in Hamburg. The scientists from Helmholtz Institute Jena and DESY is developing high power lasers with pulses in the femtosecond range. One femtosecond is a quadrillionth of a second. Shorter laser pulses allow more precise working of materials, for instance. Also, such short laser pulses open up new innovative applications like 3D nanostructuring. For science, the technology is of great importance.

The novel Laser systems from Class 5 Photonics are deployed worldwide in leading research laboratories. SuperNova OPCPA is the Class 5 Photonics flagship product. The SuperNova OPCPA enables researchers to perform experiments ten times faster than with conventional lasers. ■

Read an interview with entrepreneur Dr. Robert Riedel, founder of Class 5 Photonics, on page 14.

Gerhard Kraft named Honorary President of ERRS

Professor Gerhard Kraft, former Head of the GSI Biophysics department, has been named Honorary President of the European Radiation Research Society (ERRS). Kraft initiated the use of ion beams for cancer treatment and founded the biophysical research department at GSI. He was named to this honorary position in recognition of his outstanding achievements, particularly in the fields of cancer research and heavy ion therapy. The ERRS is a European nonprofit organization for the promotion of radiation research. It was founded in 1959 in order to promote communication between scientists, especially in Europe. It does this by putting scientists into personal contact and holding annual conferences, which created networks throughout Europe even during the Cold War. ■

INTERVIEW

Physicist Dr. Robert Riedel formerly worked in research. In 2014 he took a bold leap into entrepreneurial independence by starting a spin-off company of the Deutsches Elektronen-Synchrotron (DESY) and the Helmholtz Institute Jena, a branch of GSI.

Dr. Riedel, you founded the Class 5 Photonics company together with Dr. Michael Schulz. What are you selling?

We're producing the first high-performance femtosecond laser. A femtosecond corresponds to 10^{-15} seconds. In other words, it generates extremely short pulses of light. The characteristics of this laser are high reliability and strong performance. It delivers between ten and 100 times more output in the femtosecond range than previously available systems. Nothing like it has ever existed before, so I would call it a game changer. Our customers mainly come from research institutes. Thanks to the top performance of our laser, they can conduct their experiments much faster. What used to take weeks now only requires hours.

What's the secret behind your technology?

We achieve our high reliability by using industrial material processing lasers as pump lasers to supply energy. These are compact and robust systems. As a rule, they deliver pulse durations measured in picoseconds and power up to the kilowatt range. Furthermore, we use transparent nonlinear crystals and an innovative amplifier principle. The energy surplus exits from the crystal as visible radiation, and thus no heat is generated in the laser amplifier. As a result, we can achieve higher performance. Instead of a traditional laser oscillator, we generate what's known as "white light." A spectrum of light is generated in the crystal, and we then select the parts that will be amplified.

How did you establish your company?

When we were doing our research work, we realized there was a demand for femtosecond lasers within the research community. This led to our founding of the spin-off, a step that was supported by DESY and the Helmholtz Institute Jena — and thus by GSI. We launched the company with a staff of two people in 2014, and we received funding from Helmholtz Enterprise. We've won several prizes for this technology, most recently the Prism Award 2018 (Editor's note: See also report on page 13.) Today we have a staff of five, and we're profitable and self-supporting. We expect to have a turnover of about €2 million this year.

What are the differences between operating as an independent entrepreneur and working at a research institute?

Working in the company is very exciting from a strategic point of view. In the same way that you have to position yourself in the research community, for example through your publications, you also have to position yourself in the corporate world. You've got partners and competitors. You have suppliers, you operate within networks, and you have to find the place that's right for you. As an entrepreneur, you've got additional obligations and you wear different hats. Sometimes it's the finance hat, sometimes the sales hat, at other times the human resources hat. You experience job interviews from the other side of the table. These are new experiences that go above and beyond a career in science.

Would you make the leap into entrepreneurship again?

Yes, I certainly would. If you're a scientist, as a rule you have the resilience you need in order to bang your head against a wall as long as necessary until it breaks and you reach your goal. Of course there are ups and downs, as well as moments of regret. But that has to be weighed against the joy you feel when you've achieved something. Sometimes I miss conducting experiments. On the other hand, Michael Schulz and I as "masters of the technology" still go to our customers to install our systems. A company like ours is also an experiment, so it never gets boring.

Have you got any recommendations for other company founders coming from research? What would you advise?

Success depends largely on luck and the right timing. You shouldn't think too much about the risks — instead, keep your eyes on the future. If you're a researcher with only a temporary contract, in many cases you've got less to lose than you might think. Basically you should always be open to the idea of asking other people for advice. Sometimes you have to take a leap of faith, ask questions, and actively communicate. There are lots of high-caliber consultants that you can meet at presentations or other events during "startup days," for instance. Just start talking to them and ask them your questions. In addition, at our company a very mixed team has proved to be successful. Physicists often think they can do just about everything, but at some point you lack the resources. For example, in the area of sales it's perfectly fine to hire someone who has a different kind of experience.

How do you spend your time when you're not working on lasers? Have you got any hobbies?

In addition to working, I've also managed to start a family. I prefer to spend my leisure time with my wife and my two children. For me, that's the most important thing of all.

Scientists succeeded in measuring liquid water at minus 42.6 degrees Celsius..

SPECTACULAR LOW TEMPERATURE

Research team measures liquid water with a temperature of minus 42.6 degrees Celsius

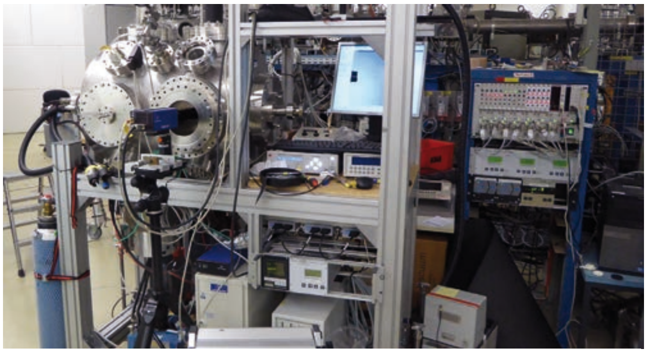
It is a spectacular low temperature: A research team headed by Robert Grisenti from GSI has successfully detected liquid water at a temperature far below the freezing point: minus 42.6 degrees Celsius. This discovery is the result of development work on experiments for the future accelerator center FAIR, but it could also enable us to make great progress in our understanding of the earth's climate.

Although it has long been known that water can remain liquid far below zero degrees Celsius without freezing, the result depends on the volume of the sample used. The fast evaporative cooling of tiny water droplets in a vacuum gives scientists a good means of analyzing supercooled water, i.e. water that is still liquid even though its temperature is below freezing. However, it's difficult to get a reliable value for the droplet temperature under such extreme experimental conditions. Because this value is of crucial importance for further studies, the reliable and exact measurement of the temperature of supercooled water is a great challenge.

In their research, the scientists demonstrated a new technology that achieves an unparalleled level of precision when measuring the temperature of extremely small droplets of water. The system does this by determining the temperature of a droplet on the basis of its diameter. In this process, uniform droplets of warm ultrapure water that are only a few thousandths of a millimeter wide are sprayed in a targeted jet of liquid into a vacuum chamber. The upper layers of the droplets evaporate and the inner layers cool off greatly, so the droplets shrink. This shrinkage can be precisely measured with optical methods, and the result is used to determine the droplets' temperature. A key element for such high-precision measurements is the unique instrumentation available at GSI for Raman spectroscopy, in which the droplets are illuminated with a laser beam. The spectrum and form of the scattered light enable scientists to determine the diameter of the droplets.

In its research, the team can build on the expertise gathered over many years at GSI and at the international FAIR accelerator center, which is currently under construction. This expertise especially benefits the development of targets for atomic and nuclear physics experiments. Inside the accelerator facility, the particle beams are guided to the experimental stations, where they hit the targets made of the material samples. Targets that consist of tiny jets of liquids also have to be specially developed for such studies in the target hall and in the experimental storage rings at GSI and FAIR. FAIR will be a unique accelerator center with great knowledge potential. As a result, the current research with supercooled water for the development of targets for FAIR is also an example of the innovation potential at FAIR.

Droplets of supercooled water can also be found in nature — in the upper layers of the earth's atmosphere, where they exist under conditions that are similar to those created experimentally by the research team. That's why the work being conducted by the scientists under the direction of Robert Grisenti can also improve our understanding of ice formation in the atmosphere. It is thus an important step on the path toward the development of reliable climate models. ■

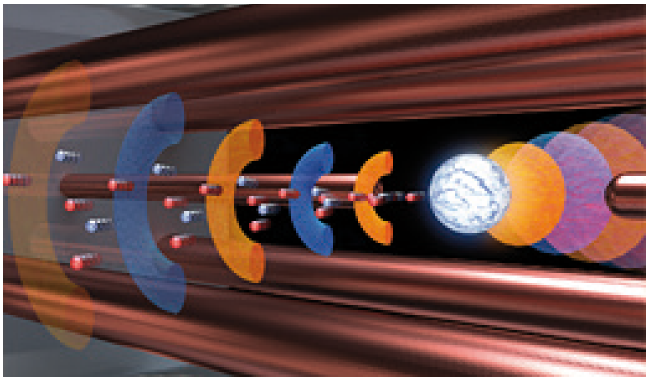


With an experimental setup at GSI, a team of researchers has detected liquid water far below the freezing point at a temperature of minus 42.6 degrees Celsius.

Playing billiards with a laser beam

A research team led by physicists at Ludwig Maximilians University (LMU) in Munich reports a significant advance in laser-driven particle acceleration. Using tiny plastic beads as targets, they have produced proton bunches that possess unique features, opening up new opportunities for future studies. The experiments were performed at the PHELIX laser on the campus of GSI und FAIR. The physicist present their research results in the scientific journal Nature Communications.

A new development in accelerator technology are laser-driven plasma accelerators. This strategy uses the intense electric fields associated with pulsed, high-energy laser beams to accelerate electrons and protons to speeds approaching that of light. Hitherto, a thin metal foil has been used as a source for the protons. Physicists at LMU have now replaced the foil target by levitating plastic microspheres with diameters of one-millionth of a meter. They are so tiny that they can't be stably positioned by mechanical means.



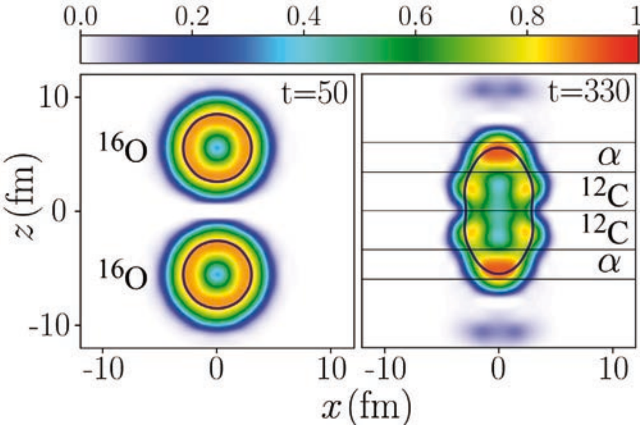
The laser beam approaches the electrodynamic particle trap from the left and impinges on the levitated plastic microsphere, accelerating a bunch of electrons and protons.

Instead, the researchers used an electric field to levitate the target particle. Via the impact of a powerful laser pulse at the spheres, a bunch of protons was blasted from the target and accelerated to velocities approaching the speed of light. The basic approach is analogous to collisions between billiard balls. One of the balls is made of light and the other is the tiny levitated target. The resulting velocity distribution is much narrower than that obtained when thin metal foils are used as targets. This novel approach to the generation of proton beams will make experiments feasible which have hitherto been out of reach. ■

Detailed fusion: The visualization of clustering in nuclear collisions

Colliding nuclei can fuse and form a new nucleus. Sometimes this fusion is temporary — the newly formed nucleus is in an excited state and decays after a short period of time into a stable state or falls apart. Such a short-lived nucleus is called a pre-compound. In a publication of the journal Physical Review C the two scientists Dr. Bastian Schütrumpf from GSI and Dr. Witold Nazarewicz from the Michigan State University, USA, take a closer look at the inner structure of such pre-compounds.

Atomic nuclei consist of two building blocks, the protons and neutrons. Schütrumpf and Nazarewicz developed a model to predict the behavior of these building blocks and also to visualize it. The new technique demonstrates that groups of protons and neutrons form temporary clusters which correspond to smaller, stable nuclei within the larger nucleus produced by the collision. These clusters are variable and can change between different states.

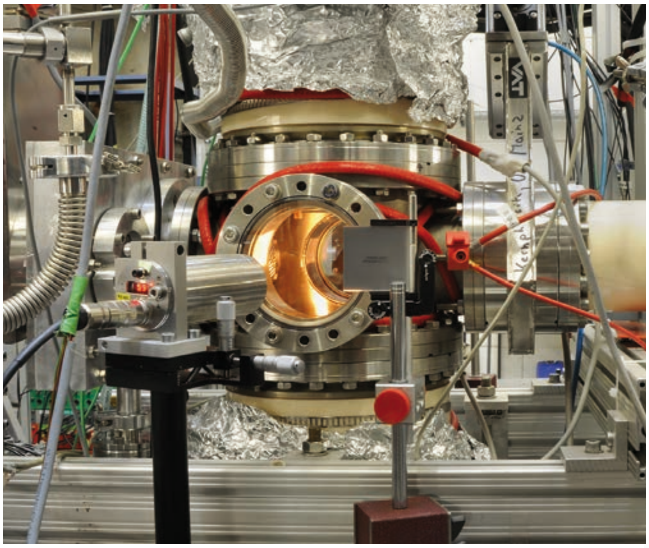


Visualization of clustering in the collision of two oxygen nuclei.

The researchers analyzed reactions triggered by collisions of oxygen, calcium, and carbon, which can – depending on the collision energy – result in either fusion or fission. The calculations reveal clusters corresponding to the nuclei helium-4, carbon-12, magnesium-24, and argon-36. For example, two oxygen-16 nuclei colliding at an energy of 20 mega electron-volt form a pre-compound in which two deformed carbon-12 clusters oscillate against two helium-4 nuclei (alpha particles).

"Such fleeting nuclear states often appear in stars or other space phenomena. This is why they are of great interest to the scientists and are frequently examined in collision reactions. To understand their structure is fundamental for deciphering them," explains Dr. Bastian Schütrumpf, who works as a post-doc in the GSI research department "Theory". "Previous theory and experiments have suggested the existence of clusters in the pre-compound. Existing models, however, couldn't reveal their detailed nature." To address this problem, Schütrumpf and Nazarewicz used a mathematical tool originally developed to describe electron arrangements within atoms and molecules and applied it to the nucleons. ■

Probing nobelium with laser light — Successful laser spectroscopy measurements reveal size and shape of the nucleus of element 102



Gas-filled optical cell for laser spectroscopy of nobelium isotopes: the cell is mounted behind the velocity filter SHIP (left). The glowing filament is used to evaporate nobelium atoms for laser spectroscopy.

Sizes and shapes of nuclei with more than 100 protons were so far experimentally inaccessible. Laser spectroscopy is an established technique in measuring fundamental properties of exotic atoms and their nuclei. For the first time, this technique was now extended to precisely measure the optical excitation of atomic levels in the atomic shell of three isotopes of the heavy element nobelium, which contain 102 protons in their nuclei and do not occur naturally. This was reported by an international team lead by scientists from GSI. Nuclei of heavy elements can be produced at minute quantities of a few atoms per second in fusion reactions using powerful particle accelerators. The obtained results are well described by nuclear models, which suggest the nuclei to have a bubble-like structure with lower density in their center than at their surface. The results were published in a recent article in Physical Review Letters.

Atoms consist of a positively charged nucleus surrounded by an electron shell. The inner electrons penetrate the volume of the nucleus and thus atomic level energies are influenced by the size and shape of the atomic nucleus. A difference in size of two different atomic nuclei resulting, for example, from a different number of neutrons results in a small shift of electronic energy levels. Precise measurements of these energies are possible using laser light. Energy shifts are traced by varying the frequency and correspondingly the color of the light required to excite electrons to higher energy levels. So far, this method could only be applied to isotopes of lighter elements which are produced at larger production rates and whose atomic structure was already known from experiments with abundant long-lived or stable isotopes. Nuclei of elements above fermium (Fm, Z=100) can be produced at minute quantities of a few atoms per second in fusion reactions and generally exist only for at most a few seconds. Therefore, their atomic structure was so far not accessible with laser spectroscopic methods.

In the current experiments, nobelium isotopes were produced by fusion of calcium ions with lead at the velocity filter SHIP at GSI's accelerator facility. To enable laser spectroscopy, the high energetic nobelium atoms were stopped in argon gas. The results are based on a preceding experiment also conducted at GSI, exploring the atomic transitions of nobelium (No). The chemical element with atomic number 102 was discovered about 60 years ago. The recent experiment investigated the isotopes No-254, No-253 and No-252, which differ in the number of constituent neutrons in their nuclei, with laser spectroscopy. The rates available for the experiment reached values below one ion per second for the isotope No-252.

From the measurements of the excitation frequency for the individual isotopes, the shift in color of the required laser light was determined for No-252 and No-254. For No-253, the fragmentation of the line into several hyperfine components induced by the single unpaired odd neutron was also resolved. The sizes and the shapes of the atomic nuclei were deduced from using theoretical calculations of the atomic structure of nobelium, which were carried out in collaboration with scientists from the Helmholtz Institute Jena in Germany, the University of Groningen in the Netherlands, and the University of New South Wales in Sydney, Australia. The results confirm that the nobelium isotopes are not spherical but are deformed like an American football. The measured change in size is consistent with nuclear model calculations performed by scientists from GSI and from the Michigan State University in the USA. These calculations predict that the studied nuclei feature a lower charge density in their center than at their surface.

Thanks to these pioneering studies, further heavy nuclides will be accessible for laser spectroscopic techniques, enabling a systematic investigation of changes in size and shape in the region of heavy nuclei. These experiments are so far only possible at GSI and allow for a unique in-depth understanding of the atomic and nuclear structure of the heaviest elements. The results also play a role for the future facility FAIR, which is currently under construction at GSI. The same techniques and methods could also be employed in the low-energy branch of FAIR's super fragment separator.

The experiments were conducted by an international team of scientists from GSI Helmholtzzentrum für Schwerionenforschung, Johannes Gutenberg-University Mainz, Helmholtz institute Mainz, TU Darmstadt, KU Leuven (Belgium), University of Liverpool (UK) und TRIUMF (Vancouver, Canada). ■

Experiments at the PHELIX laser lab.

HIGH-PERFORMANCE LASER

Hot plasma and fast ions: PHELIX celebrates ten-year anniversary

The high-performance laser PHELIX at GSI is in operation for ten years. At PHELIX, scientists from around the world have the unique opportunity to conduct experiments that combine laser beams and ion beams produced in the existing accelerator facility. This makes it possible to study extreme states of matter, such as those that occur in stars or inside large planets.

PHELIX (Petawatt High-Energy Laser for Ion Experiments) is one of the most powerful lasers in the world. It can deliver laser pulses with energies of up to 1,000 joules and laser pulses with a power of up to half a petawatt. The output power is quintillion times (billions of billion times) greater than that of a laser pointer or a laser in a CD player. PHELIX is so large that it takes up an entire building the size of a two-story house with a clean-room atmosphere inside. The laser beam, which has a diameter of 30 centimeters, is guided to the site of the experiment using special mirrors and focused on a point. A laser pulse can be generated only about every 90 minutes.

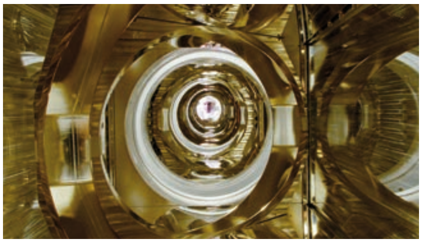
Since it was first started up in the year 2008, PHELIX has completed a total of 115 operational periods or "beam times." Over 100 experiments were successfully performed during these periods, resulting in more than 70 scientific publications. For years, there has been great demand among the research community for beam time at PHELIX. The amount of beam time requested regularly exceeds what can be offered. For this reason, there is an established selection procedure to allow research groups to carry out their experiments at PHELIX. Following the calls to submit proposals for experiments, these proposals are examined by an international committee, and experiments are then selected based on scientific relevance and feasibility.

"At PHELIX, in combination with the GSI accelerator facility scientists can conduct experiments that aren't possible anywhere else in the world," says Dr. Vincent Bagnoud, head of the "Plasma Physics/PHELIX" research department at GSI. "The objective is to study matter when it exists in the form of what is called plasma. In this state, the electron shell of atoms is completely or partially separated from the atomic nuclei. This is only possible under extreme conditions and above all at high temperatures of the sort found in stars or inside large planets such as Jupiter." Plasma is one of the four states of matter — the other, more familiar states being solid, liquid and gaseous. In our everyday lives, we encounter less energetic types of plasma, such as a candle flame or a bolt of lightning during a thunderstorm.

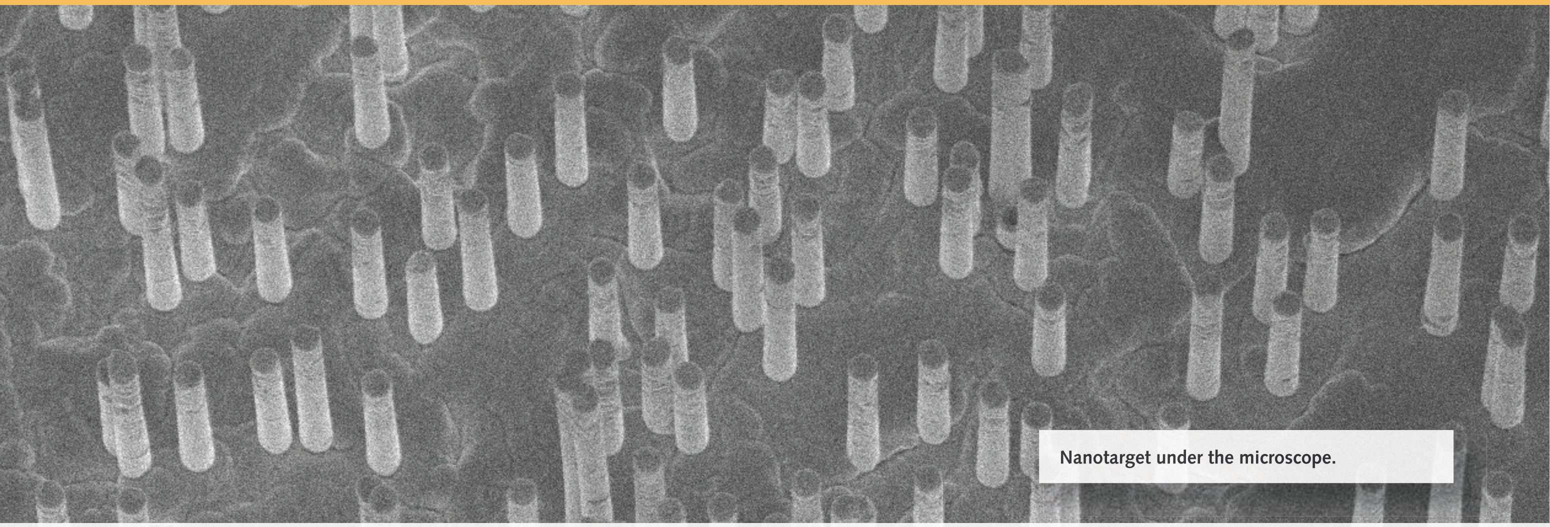
In their experiments, the researchers expose samples of matter to radiation. These samples can be heated up with the laser beam to such a degree that a plasma forms. Just fractions of a second later, they can be bombarded with ions. An analysis of the resulting reactions makes it possible to study the properties of the plasma.

The possibility of using the laser beam to accelerate ions and then transfer them to stationary conventional accelerator structures is also being studied. This combined use of the laser and ion accelerator is unique and enables the generation of very brief ion pulses with high particle counts.

Further improvements are contemplated for the future, especially for use at the FAIR accelerator facility: In the long term, researchers are aiming to use ion acceleration with the laser to achieve different sorts of ions, higher energies and greater intensities. An increase in the pulse repetition rate of the laser is also planned. ■



The inside of an amplifier for the PHELIX laser.



Nanotarget under the microscope.

NEW TARGETS

Cooperation between materials research and plasma physics improves laser acceleration

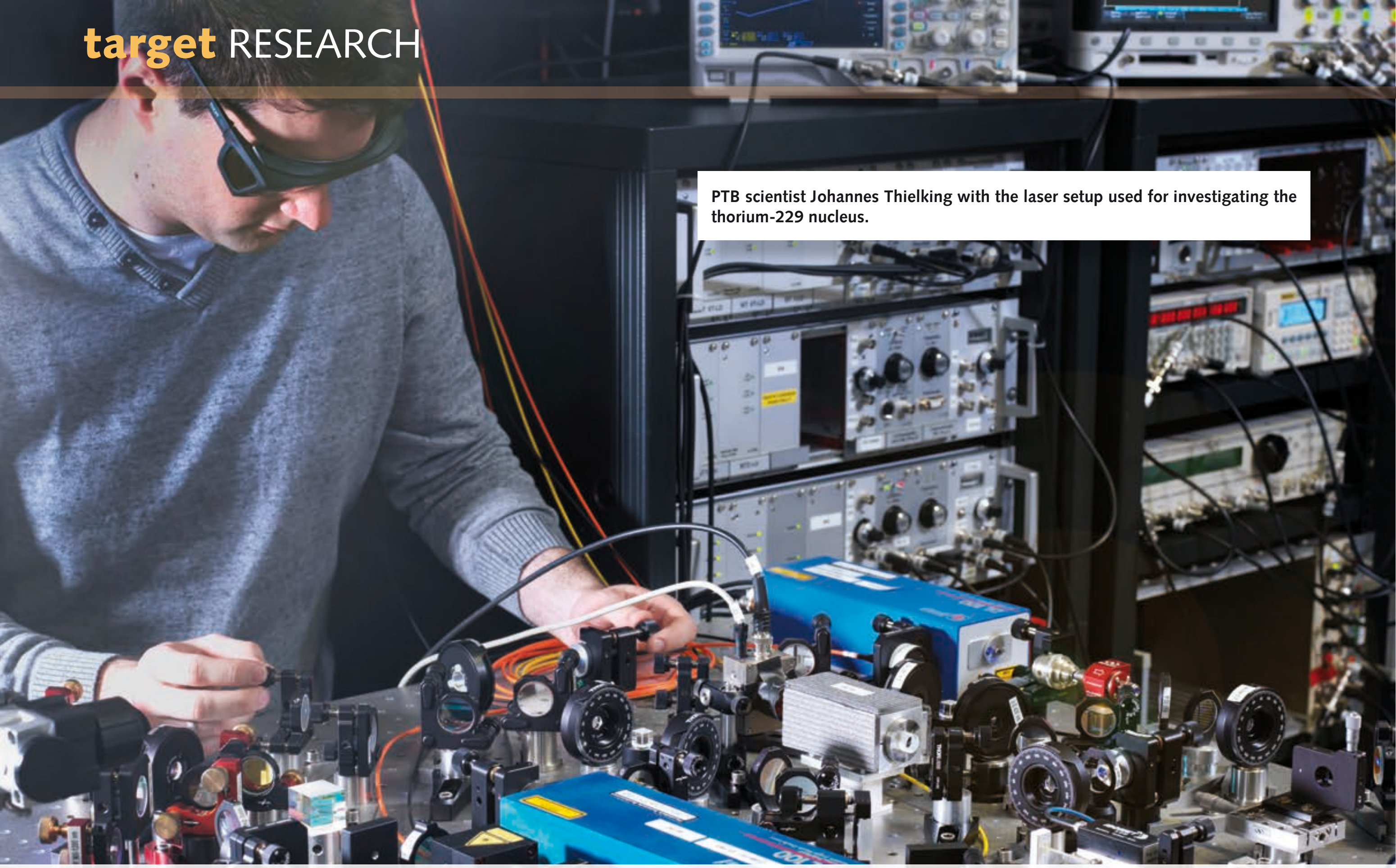
The use of nanostructured targets enables the PHELIX laser to accelerate considerably more particles to substantially higher energies. The experiment with the high-performance laser was conducted at the GSI/FAIR campus by scientists from GSI and FAIR, the Goethe University Frankfurt and the Helmholtz Institute Jena. The innovative nano target was created at GSI's Materials Research department. The results give laser-driven particle acceleration a boost, and also harbor considerable potential for future plasma research at the FAIR accelerator facility.

One of Germany's strongest lasers is located on the campus of GSI and FAIR: the Petawatt High-Energy Laser for Ion Experiments (PHELIX). By focusing all of the light energy into a hair-thin beam, plasma physicists can use the laser to study states of matter under conditions that are similar to those inside stars and giant planets. However, they also test possible applications such as laser-driven particle acceleration. To do this, scientists shoot the laser at a target to study how the ultrapowerful pulse of light affects the material. Now, scientists have, for the first time, tested a target with a nanowire surface instead of one with a smooth surface. "In the new surface, extremely thin nanowires are located close to one another like tall tree trunks in a dense forest that is bombarded from above by a laser," explains Paul Neumayer, a plasma physicist at GSI and the leading scientist of the experiment. Nanotargets are extremely fragile structures. Until recently, laser pulses would destroy such targets before fully reaching them. In cooperation with the Helmholtz Institute Jena, the scientists at FAIR have greatly improved PHELIX's temporal contrast, which means the laser pulse is now extremely "cleanly" delineated in terms of time. As a result, the wires are immediately hit by the laser's full energy density, thus stripping off the electrons from the target atoms at one blow. This creates an electrostatic field, which, in turn, can accelerate lightweight particles.

"The new target enabled us to accelerate 30 times more particles than with the normally employed smooth foil targets under the same conditions," says Neumayer. "Moreover, we increased the energy of the accelerated particles by 2 to 2.5 times." There are two reasons for this improvement. First, a nanotarget has a much higher surface area than a smooth one, thus intensifying the laser's interaction with the material. Second, the laser pulse can penetrate deep into the target's structure in the spaces between the wires. As a result, the laser energy can be deposited with much higher densities than would normally be achievable with the laser light.

In addition to making laser-driven particle acceleration more efficient, the new targets have another benefit: they greatly increase the X-ray emissions of the hot plasma. "This is not only a huge advantage for the measurement of exotic plasmas, but also opens up interesting prospects for the development of extremely intense short-pulsed X-ray sources for future FAIR experiments," explains Neumayer.

The innovative nanotargets were developed by Dimitri Khaghani as part of his doctoral dissertation. Khaghani is a laser and plasma physicist who earned his doctorate at Goethe University Frankfurt. For his dissertation, he worked together very closely with GSI's Materials Research department, which has been researching and producing nanowires for years. Nanowires grow in tiny channels in plastic foils. To create these channels, researchers first bombard the foils with heavy ions from a linear accelerator. The areas damaged along the ions' path are then chemically etched to turn them into open channels that are subsequently filled using an electrochemical method. "This process enabled us to test nanowires made of different materials and of various lengths and diameters so that we could find out when laser acceleration is most efficient," says Khaghani. "The synergy effect achieved through the close cooperation between the Plasma Physics and Materials Research departments on the campus certainly contributed to the success of the experiments." ■



PTB scientist Johannes Thielking with the laser setup used for investigating the thorium-229 nucleus.

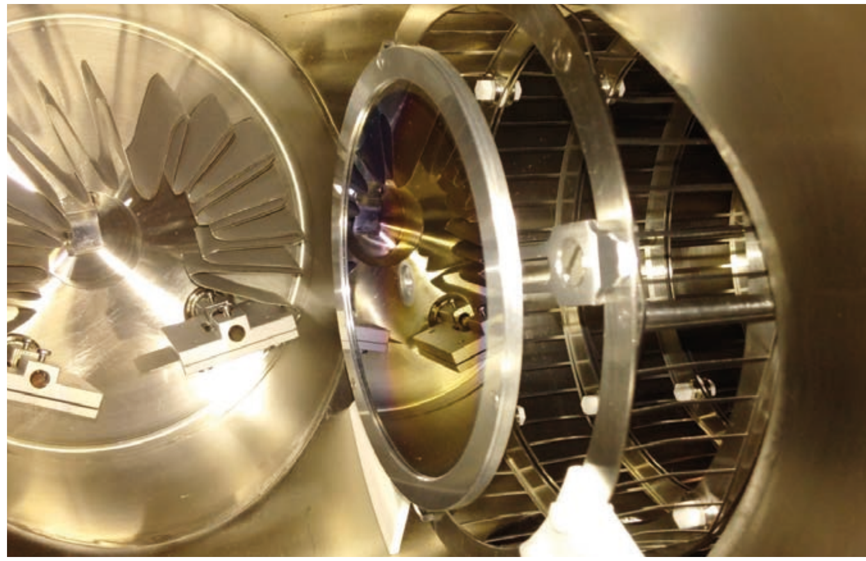
NUCLEAR CLOCK

Oscillations in the atomic nucleus of thorium-229 to be used as pulse generator

Precise time measurements play a vital role in our daily life. They allow reliable navigation and accurate experimenting and provide a basis for world-wide synchronized exchange of data. A team of researchers of PTB Braunschweig, Ludwig-Maximilians-Universität München (LMU), Johannes Gutenberg University Mainz (JGU), the Helmholtz Institute Mainz (HIM), and GSI now reports on a decisive step toward the potential development of a nuclear clock, which bears the potential to significantly outperform the best current atomic clocks. The only known excited state of an atomic nucleus that is located at a suitably low excitation energy to be accessible by optical techniques, as they are in use in current atomic clocks, exists in thorium-229. Fundamental properties of thorium-229 in this state have now been determined, the researchers report in the journal Nature.

Some 15 years ago, researchers at PTB in Braunschweig, the National Metrology Institute of Germany, developed a concept for the design of a novel optical clock with unique characteristics. Instead of exploiting oscillations in the electron shell, they proposed that one could make use of a transition between energy levels within an atomic nucleus as the basis for a nuclear clock. Because the protons and neutrons in the nucleus are orders of magnitude more densely packed and much more tightly bound than the electrons in the outer electron shells, they are much less susceptible to perturbation by outside forces that might affect their transition frequencies. Therefore, a nuclear clock should be far more stable and precise than present-day optical atomic clocks. However, the typical frequencies of nuclear transitions are much higher than those that occur in electron shells and generally lie in the gamma-ray region of the electromagnetic spectrum. This means that they cannot serve as the basis for an optical atomic clock, as all such clocks are based on excitation by microwaves or laser light.

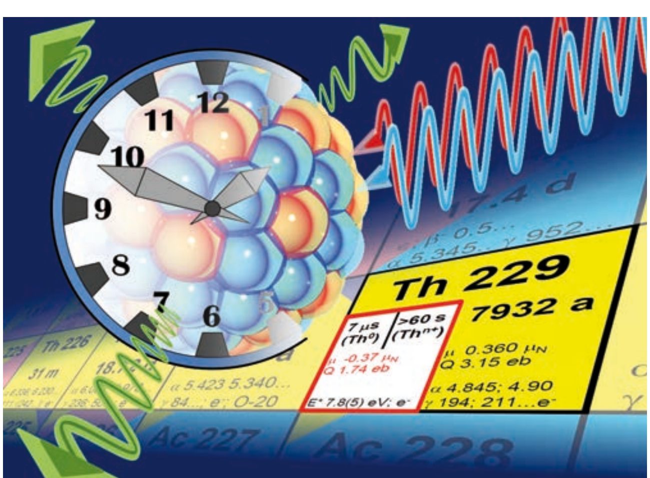
The exception to this rule is found in an unstable isotope of thorium, thorium-229, which exhibits a quasi-stable, so-called isomeric nuclear state with an extraordinarily low excitation energy. The frequency of the transition between the ground state and this isomeric state corresponds to that of ultraviolet light. This transition can therefore be induced by means of a laser-based technique similar to that used in state-of-the-art optical atomic clocks. More than ten research groups worldwide are now working on the realization of a nuclear clock based on the thorium-229 isomer. Experimentally speaking, this is an exceedingly challenging endeavor. While the existence of the state was inferred from data obtained over several decades, the direct detection and hence unambiguous proof of its existence in the first place was achieved in 2016 in collaborative work of the LMU group together with the groups in Mainz and Darmstadt. They subsequently succeeded in measuring its half-life. However, it has not been possible to observe the nuclear transition by optical means yet, as the exact excitation energy of the isomer has not been determined with sufficient precision. The transition itself is extremely sharp — as required for timing purposes — and can only be induced if the frequency of the laser light corresponds exactly to the difference in energy between the two states. The quest for the magic frequency may be compared to the proverbial search for a needle in a haystack.



The uranium-233 source (large disk in center of image) produced at the Johannes Gutenberg University Mainz mounted inside the experimental apparatus at the LMU Munich. Components of the setup are reflected in the surface of the source.

Measuring the basic features of the thorium-229 isomer

A collaborative effort by researchers and engineers at PTB, LMU, Johannes Gutenberg University Mainz, the Helmholtz Institute Mainz, and GSI has now achieved an important breakthrough in this search. The researchers have measured some of the basic features of the thorium-229 isomer, such as the size of its nucleus and the general form of the distribution of protons. In the present study, the nuclei were not excited from the ground state by means of laser light, as they would be in a future clock. Instead, the isomer was produced by the alpha-decay of uranium-233 and decelerated in a device developed at LMU, extracted, and stored in an ion trap as Th^{2+} ions. The uranium-233 source was provided by the groups in Mainz und Darmstadt. For this purpose, uranium-233 was chemically purified and its decay products were removed to avoid any influence on the measurements. Subsequently, suitable sources were deposited as homogenous thin films on a silicon layer in an electrochemical procedure for the laser experiments of PTB at the LMU apparatus. Christoph Düllmann, professor at the Institute of Nuclear Chemistry at Johannes Gutenberg University Mainz and head of the involved research teams at HIM and GSI, said: „This is a fascinating interdisciplinary team of physicists and chemists studying a topic that connects nuclear and atomic physics. Our contribution is testimony to the need of nuclear chemistry expertise in the preparation of samples suitable for experiments in a variety of fields in contemporary physics and chemistry research."



The nuclear clock is based on a transition in the atomic nucleus of thorium-229. The corresponding cut-out from the chart of nuclei is visible in the background. The thorium-229 ground state is listed with its half-life of 7,932 years.

With the aid of laser systems specifically developed for spectroscopic analyzes of this ionic species at PTB, researchers have now been able to determine the transition frequencies in the electron shell of Th^{2+}. These parameters are directly influenced by the state of the nucleus and encode valuable information on its physical properties. On the basis of theoretical modeling alone, it has not been possible to predict how the structure of the thorium-229 nucleus in this unusually low-excited isomer might behave.

Professor Thomas Stöhlker, Vice Director of Research and head of the Atomic Physics division at GSI, added: „These fantastic new results are very helpful to determine the energy of the transition of Th-229 in future experiments at the storage rings of GSI and FAIR with high precision." Furthermore, it is now possible to probe the structure of the electron shell to confirm a successful laser-excitation of the nucleus into the isomer. The hunt for determining the optical resonance frequency that triggers the transition to the isomeric first excited state of the thorium-229 nucleus is not yet over. But researchers now have a far better idea of what the needle in the haystack really looks like. ■

Radon therapy — New project receives €4 million in funding

A recent kickoff meeting on the GSI/FAIR campus in Darmstadt marked the beginning of the new research project GREWIS alpha on radon therapy.

A multi-year research project led by GSI has been investigating the anti-inflammatory therapeutic effect, as well as the risks, of treatment with the inert gas radon. The project has recently received a green light for continuing this research. A total of €4 million will be available to it in the coming four years, with €1.9 million of that amount going to the groups working at GSI.

The project funding will come from the German Federal Ministry of Education and Research. The new project, GREWIS alpha, is the successor of the project called GREWIS, a German acronym that stands for "the genetic risks and anti-inflammatory effect of ionizing radiation." The word "alpha" stands for the strongly ionizing alpha particles that are emitted when radon and its daughter nuclei decay. The Scientific Managing Director of GSI and FAIR, Professor Paolo Giubellino, was pleased with the research funding: „The decision shows that the wealth of experience regarding biophysical und biological radiation research here at GSI has a very promising potential for the future. We will continue to conduct research in this area to gain fundamental insights, but also to enable optimal treatment options and targeted prevention. Biophysics is also an important part of our strategic long-term plans for the future accelerator facility FAIR."

The radiation biologist Professor Claudia Fournier from the Biophysics Department of GSI is the overall coordinator of this joint project, in which GSI is cooperating with TU Darmstadt, Goethe University Frankfurt, and the University of Erlangen-Nuremberg. A total of seven work groups from four institutions are working on this research project. The Karlsruhe Institute of Technology (KIT) is the project's sponsor. A recent kick-off meeting on the GSI/FAIR campus marked the beginning of the new project. It was attended by over 30 participants from TU Darmstadt (Department of Biology), Goethe University Frankfurt (Centre for Radiotherapy), the University Clinic Erlangen, and the biophysics department at GSI, as well as representatives of KIT.

The radioactive element radon is used in the form of baths or inhalations in healing caves and baths to treat many patients, and it has met with success. The pain-relieving effects of low-dose radon therapies for patients with painful chronic inflammatory illnesses have been known for centuries on the basis of experience. These therapies are used for diseases of the locomotor system such as rheumatism and arthrosis, as well as diseases of the respiratory system and the skin, including neurodermatitis and psoriasis. But even though it is nowadays assumed that low doses of radiation can mitigate chronic inflammation, the cellular and molecular mechanisms of action that underlie the observed pain relief, especially in the case of a radon therapy, are still largely unknown. As a result, the objective of the GREWIS researchers is to investigate with increasing precision the potentially helpful aspects as well as the risks of low-dose exposure to radon and to put this therapy on a solid scientific foundation. ■

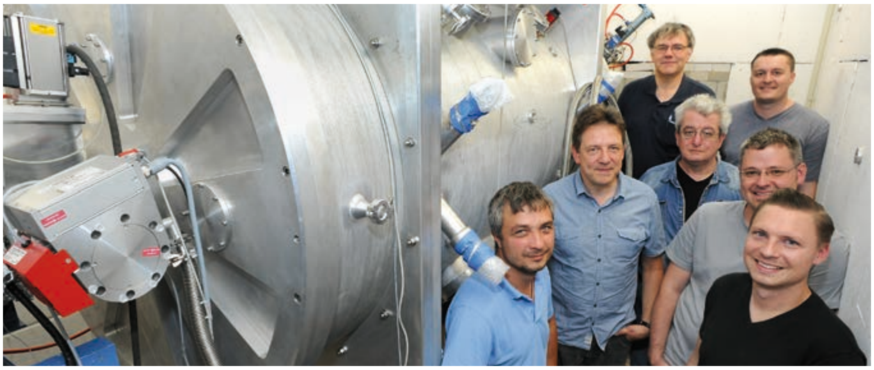
Test results for new type of accelerator structure published

In collaboration with GSI, physicists and engineers of the Helmholtz Institute Mainz and Goethe University Frankfurt have conducted successful tests for a new type of accelerator structure: a new design for a superconducting CH-cavity (crossbar H-mode cavity) has recently been tested with an ion beam from the GSI High Charge State Injector.

This is a key step toward the proposed superconducting (continuous-wave) linear accelerator (cw linac), which has the potential to open up new prospects for research with its continuous particle beam. The researchers have now reported on their results in the scientific journal "Physical Review Accelerators and Beams" (PRAB).

The demonstrator of the continuous-wave linac was studied in a test environment at GSI. During this study, argon ions were injected into the new accelerator structure and accelerated. The test module consisted of a CH-cavity surrounded by two superconducting high-field magnets. Dr. Winfried Barth, head of the development team for the cw linac, describes the new design of the CH cavity as groundbreaking and summarizes the successful test by saying: "With the demonstrator of the cw linac, we have attained full particle acceleration up to the desired beam energy. With an acceleration voltage of 4.0 megavolts, the demonstrator accelerated a heavy-ion beam with an intensity of 1.5 particle microamperes to the target energy over a distance of only 70 centimeters." The result confirms the effectiveness and capabilities of the new design of the CH cavity.

A continuous particle beam from the proposed continuous-wave linac is of interest for the generation and study of new chemical elements, and for experiments from the field of materials research that could also profit from the continuous beam of the proposed new linac. ■



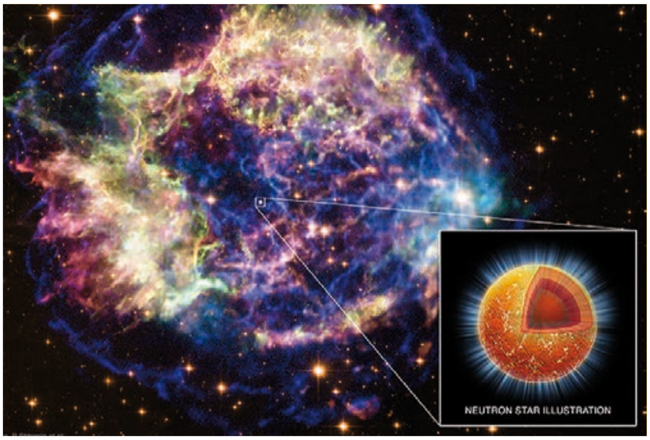
The research team in front of the demonstrator, from left to right: Maksym Miski-Oglu, Winfried Barth, Alexander Schnaase, Stephan Yaramyshev, Victor Gettmann, Manuel Heilmann and Florian Dziuba.

Simulations throw new light on the role of muons in supernova explosion mechanisms

Complex processes take place on the microphysical level when a star explodes and becomes a neutron star. According to the latest findings the role of muons in these supernovas must be reconsidered. The muons — elementary particles that were previously neglected — have an effect on the speed of the contraction to form the neutron star. Thus they also affect the neutrino-driven explosion mechanism. The findings were made by scientists from GSI and FAIR, TU Darmstadt, the Max Planck Institute for Astrophysics in Garching, and Indiana University in the USA.

What exactly happens when a star explodes and becomes a neutron star? Scientists use complex model calculations to study this question. Simulations of a neutrino-driven supernova explosion have now provided indications that the muon, an elementary particle that was previously unjustifiably neglected in the calculations, actually needs to be taken into account. This result has been published in the journal Physical Review Letters.

Muons have previously been neglected in simulations of supernova explosions because it had been assumed that they were not produced in significant quantities in such events. The scientists working with Professor Gabriel Martínez Pinedo, a theoretical physicist at GSI/FAIR and TU Darmstadt, have shown in their publication that the temperature and the electrochemical potential, however, are such that muon production is possible. "That changes the composition of the particles in the stellar material and the neutrino emission," says Martínez Pinedo. These two effects are based on the following mechanism: A neutron star forms in the interior of certain supernovae. As such a star forms, it attracts matter, and powerful gravitational forces are present. Electrons in the interior of the neutron star, however, work against the gravitation due to their mutual repulsion and so create pressure. A proportion of these electrons are now converted into muons. Because muons have a higher mass than electrons, they generate less counterpressure in the interior of the neutron star being formed. As a result, the contraction speeds up. The faster contraction gives rise to more heat, which results in more neutrinos being produced and emitted. That affects the explosion mechanism. "The models must therefore take account of muons, because they affect the supernova explosion mechanism," concludes Martínez Pinedo.



Super nova remnant Cassiopeia A with cooling neutron star.

Theoretical calculations often provide important reference points for laboratory experiments. This is also the case at GSI and FAIR. Cosmic matter can be created in the laboratory using the particle accelerators in Darmstadt. The HADES experiment and the future CBM experiment at FAIR can, for example, reach the temperatures and densities at which the muon production takes place during neutron star formation. Theoretical predictions could provide the experimental physicists with orientation when they evaluate their experiments. "For our next step we are planning simulations that will tell us more about the role of the pions," says Martínez Pinedo, looking forward. "They could also be playing an important role that is not yet completely understood." ■

Deep learning as a new tool for heavy ion physics

Deep learning is a method of machine learning where computer models learn autonomously from examples. A group of scientists from GSI, Frankfurt Institute for Advanced Studies (FIAS) and Frankfurt University showed in their publication in „Nature Communications“ that it can be used to classify data from heavy ion collisions as they occur at the GSI and also the future FAIR facility. Their goal is to determine changes in the particle matter directly from the experimental data, and thus learn more about the conditions in the early universe and in neutron star collisions.

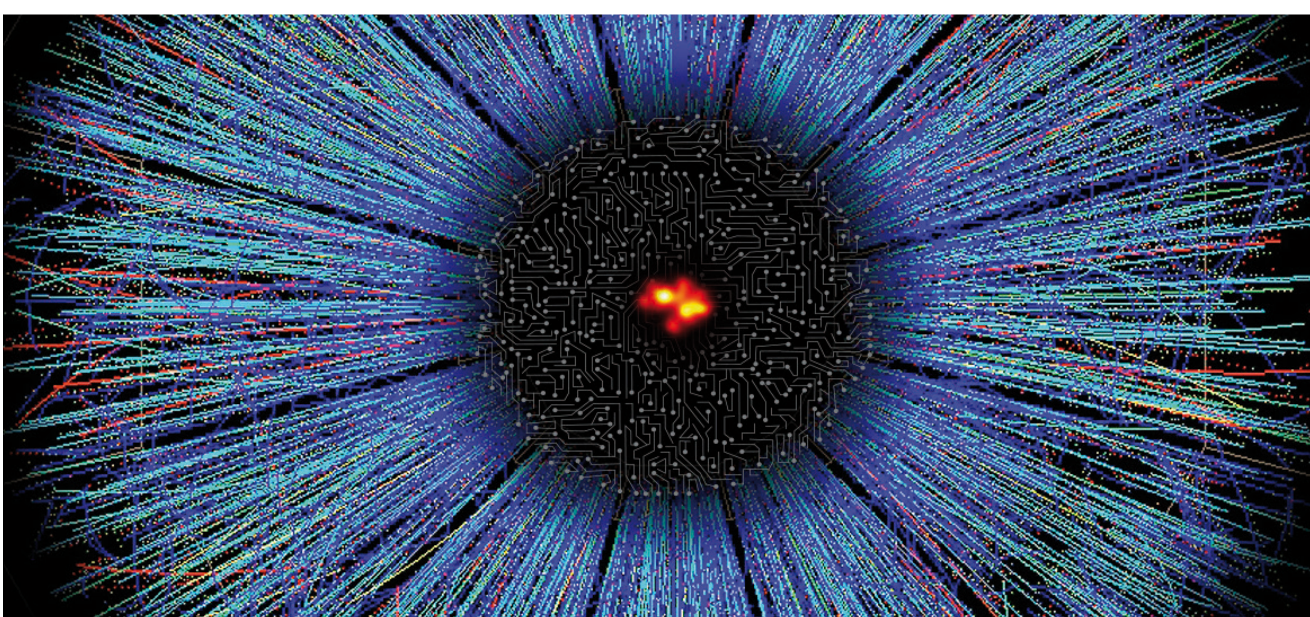
„We started the project when a human professional was defeated in the game of Go against AlphaGo designed by Google Deepmind. The news ignited our enthusiasm and we discussed a lot on whether artificial intelligence can be trained to better predict the equation of state of a particle collision,“ explains Long-Gang Pang, first author of the publication and a former FIAS postdoc, who now works at the University of California in Berkeley, USA.

Topic of his research together with Dr. Kai Zhou and Dr. Nan Su from the groups of Professor Hannah Petersen and Professor Horst Stöker, the former Scientific Director of GSI, and Professor Wang Xin-Nian (Berkeley, USA) is the study and prediction of experiments where particles collide with nearly the speed of light. One of the main open questions is whether a special state of matter, the so-called quark-gluon plasma, is generated, and how its transition to normal matter takes place. So far, some important information like the pressure or the transition between the states can not be read from the experimental data directly. Complex computer models and computing power is needed. This is where deep learning can optimize processes and improve data analysis.

The word „deep learning“ is a buzz word recently in the context of artificial intelligence, „big data“ or modern algorithms for analysis. Meantime, deep learning is already behind most voice recognition systems in smartphones or intelligent household appliances, but also used in the technology for autonomous driving. It is understood as a method of machine learning where computer models learn autonomously to carry out classifications. For this purpose, they include large numbers of pictures, texts or noises in a data base and compare them with unknown data. The systems are even able to learn from their mistakes, and can solve some problems more efficiently than humans by now, e.g. the classification of objects on pictures.

At the interdisciplinary FIAS neuro scientis already work to prescind the processes taking place in our brains for some time to develop neuronal networks from them. Convolutional Neural Networks (CNN) belong to them as well, which are the basis for deep learning. Inspiried by the work of their colleagues at the institute, Long-Gang Pang, Kai Zhou and Nan Su have trained a CNN with more than 20,000 pictures of simulated heavy ion collisions. They gave proof that it will be possible in the future to use this method to gain the phase structure and other results directly from the experimental data.

To make the method available for direct use with the experimental data, however, there is still some work in front of them. For this, among other things, they have to include the details of the detectors in their model. ■



Using pictures of heavy ion collisions the phase structure and other results can be directly obtained from the experimental data via deep learning in the future.

Research Center in Saarland 19th to join Helmholtz Association

The CISPA – Helmholtz Center i.G. will become the Helmholtz Center for Information Security – CISPA.

The subject of information security will become far more significant within the Helmholtz Association in the future. The Assembly of Members of Germany's largest research organization approved the admission of the CISPA Helmholtz Center for Information Security as of January 1, 2019.

"Digital information is playing an increasingly important role in many areas of life," says Otmar D. Wiestler, President of the Helmholtz Association. "This means that data processing and research into data security represent a major scientific and social challenge that must be met by all Helmholtz research fields. I am delighted that we will now be in a position to pursue this topic with renewed vigor as Germany's largest research organization."

In consultation with a transfer committee, the current institution successfully underwent a scientific evaluation in spring 2018. This was a key requirement for its admission to the Helmholtz Association. Together with the German Federal Ministry of Education and Research (BMBF) and the state of Saarland, the Helmholtz Association has established a sound financial framework for the development of the new Helmholtz Center.

"We now have a superb foundation from which to tackle the major challenges of IT security," says Michael Backes, Founding Director of CISPA – Helmholtz-Zentrum i.G. GmbH. "We are very pleased that we will soon be a Helmholtz Association Center. With clear scientific and financial prospects, we can now tackle the major challenges in this field with the necessary critical mass in terms of researchers. Saarland is an outstanding location in which to undertake this work." Backes envisages current and future examples of research areas as including the security and reliability of autonomous transport systems, the development of robust IT infrastructure, and the security of personal data in the context of biomedical research.

The Saarbrücken Center for IT Security, Privacy and Accountability (CISPA) was established in 2011 thanks to project-based funding from the German federal government and was transferred to CISPA – Helmholtz-Zentrum i.G. GmbH at the end of 2017. The Center currently employs around 200 leading research scientists. As of January 1, 2019, it will become a member of the Helmholtz Association and will be known as the Helmholtz Center for Information Security – CISPA. ■

Helmholtz Association supports ATHENA with 29.99 million euro grant

ATHENA ("Accelerator Technology HElmholtz iNfrAstructure") is a new research and development platform focusing on accelerator technologies and drawing on the resources of all six Helmholtz accelerator institutions (GSI with its branch, the Helmholtz Institute Jena, as well as DESY, Jülich Research Center, Helmholtz Center Berlin, Helmholtz Center Dresden-Rossendorf HZDR and KIT). The Helmholtz Association has recently decided to fund ATHENA as a strategic development project with 29.99 million euros.

Together, these centers want to set up two German flagship projects in accelerator research based on innovative plasma-based particle accelerators and ultramodern laser technology: an electron accelerator at DESY in Hamburg and a hadron accelerator at HZDR. At both facilities, a range of different fields of application are to be developed, ranging from a compact free-electron laser, through novel medical uses to new applications in nuclear and particle physics. As soon as they have reached the necessary level of maturity to be put to practical use in a particular area, new compact devices could be built for use in other Helmholtz centers, as well as in universities and hospitals.

The work on ATHENA is closely embedded in the wider context of European research through the EU-sponsored design study EuPRAXIA, with its 40 partner institutes, which is also coordinated by DESY. Hence the top German research project ATHENA has had a clear European perspective and orientation right from the start. ■

Installation of the new measurment setup ECAL at the large-scale detector HADES.

HADES 2.0

Enhanced particle detection for the investigation of forms of matter in neutron star mergers

In the course of major alterations, a new detector system has been installed at the HADES experiment. Comprising 16 metric tons of lead glass, it will enable scientists to detect photons directly rather than by means of reconstruction, as was formerly the case. These photons yield information about the hot, dense matter created during accelerator experiments. This information helps scientists understand what happens when neutron stars merge.

The HADES experiment has a new large detector system. In recent months, an electromagnetic calorimeter (ECAL) measuring 4.5 meters by 4.5 meters has been installed behind the former detector. That's exceptionally good news for the more than 150 scientists who can now use HADES to produce the state of matter that is created when neutron stars merge. For them, ECAL will open up a whole raft of new scientific opportunities. Observation of gravitational waves at the LIGO and Virgo detectors had already confirmed predictions by GSI researchers that a collision of neutron stars would produce heavy elements. Thanks to HADES, the properties of compressed nuclear matter that dominates the process of such stellar collisions, can be investigated in the laboratory.

"Photons are a major decay product of this process, but up to now they couldn't be detected directly, because they don't have any mass or charge," says the physicist and technical coordinator Jerzy Pietraszko. "That meant we had to reconstruct them, which is a very difficult process." Photons are produced in large numbers when atomic nuclei from a particle accelerator collide with one another. But these photons have a wide variety of origins. They are among the decay products of larger particles from the hot, dense nuclear material produced in the collision. "Lots of the photons are uninteresting for us," Pietraszko explains, "but every now and again a collision produces particles that provide an especially large amount of information about what happens at the point of collision and therefore about the matter in a neutron star merger. These particles decay in various ways. In order to be able to locate them in the data, it's important to know the exact number of photons. ECAL will provide us with this information." ECAL comprises a blue mainframe holding 16 metric tons of lead-glass modules. When photons enter the lead glass, they generate signals allowing the direct detection of their energy. "Photons play an important role in our work," says Pietraszko. "Photons convey important information about the production of neutral fragments in the reactions. Due to them, the delivered information to determine which conditions exist in the hot, dense nuclear matter is much more complete. ECAL will also enable us to distinguish between pions and electrons. This increases the sensitivity and precision of the entire experiment."

The 978 lead-glass modules have been taken from a previous experiment at CERN and reused, saving millions in costs. Before installation, the modules were reconditioned by a team of technicians and physicists from INR Moscow, NPI Rez (Czech Republic), and the Jagiellonian University in Kraków (Poland).

This project will also play a key part in future research at FAIR. The blue mainframe was designed and constructed in Poland and is a contribution to FAIR from the Jagiellonian University. It is mounted on special rails so that the detector components can be slid apart for maintenance purposes. "This rail system will also be used at a later date for the much larger CBM detector for FAIR. It is designed to carry a weight of up to 200 metric tons," explains Michael Traxler, the Technical Coordinator of HADES. "This will therefore be an opportunity to test if the system meets all the requirements for FAIR."

The same applies to the readout electronics. These were developed by GSI, TU Darmstadt, and Goethe University Frankfurt for FAIR experiments including PANDA, CBM, and HADES. Moreover, they can already be used during beam times for current HADES experiments. In other words, this work will provide valuable experience for future experiments at FAIR.

The "HADES 2.0" detector will make its debut in coming beam times during Phase 0 of FAIR. The experiment is scheduled to start with around one month of beam time. "We'll be starting with fully ionized silver from the accelerator," says Traxler. "After that, as soon as we have more beam time we'll be doing experiments with high primary intensities for a secondary pion beam." ■

The ECAL on the rail system is connected to the existing HADES detector.

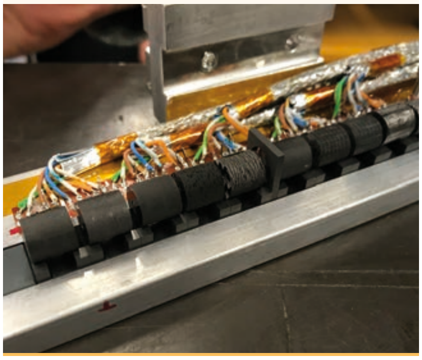
Targets at GSI

A variety of targets is in operation in the GSI accelerator experiments. In each issue of the target magazine we present one of them in detail.

Carbon for FAIR

The GSI materials researchers conduct tests of various composite materials made of carbon — which stand out due to their low density and their high radiation hardness — for their utilizability in FAIR and other accelerators with high beam intensities. Due to the low density, energy amounts deposited in carbon are relativly small and beam induced shockwaves are effectively mitigated. Carbon composites could be used as beam catchers e.g. when primary and secondary beams are separated at the Super-FRS. Also the lifetime of a production target for antiprotons can be increased by an additional envelope of carbon, and the temperature can be decreased due to a better thermal conductivity.

Targets made of various carbon materials with a tantalum core in the test experiment.



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GSI operates a unique large-scale accelerator. Researchers from around the world use this facility for experiments on the building blocks of matter and the evolution of the universe. Currently the accelerator facility FAIR is being built in international cooperation.

PARTICULARS

Marcus Bleicher again Scientific Director of HIC for FAIR

Marcus Bleicher, professor for theoretical physics at the Goethe University Frankfurt and Senior Fellow at the Frankfurt Institute for Advanced Studies, was elected to be Scientific Director of the Helmholtz International Center for FAIR (HIC for FAIR) again earlier this year by the center's Scientific Council. He succeeds Professor Rene Reifarth, who held the office from 2015 till 2018. Marcus Bleicher played an important role from the beginning as Scientific Coordinator of the center, including the planning, the application at the Hessian Ministry of Science and the Arts (HMWK), the installation of the center and the development of the program of the first funding period. From 2011 till 2015 he managed the center as Scientific Director for the first time.

FAIR and GSI in social media

Scan the QR code with your mobile phone to open the link to our social media website.

Yusuke Tsunoda receives FAIR GENCO Award for young scientists

Dr. Yusuke Tsunoda (2nd from left) from the Center for Nuclear Study at the University of Tokyo received the FAIR GENCO Award for young scientists. The award is sponsored by the FAIR-GSI Exotic Nuclei Community (GENCO) and endowed with 1,000 Euro. Tsunoda receives the Young Scientist Award for the invention of the so-called T-Plot method, a visualization method for understanding the essence of complex many-body quantum systems.

Semenov Medal for Rudolf Bock

The Semenov Medal in gold was awarded to **Professor Rudolf Bock** by Professor Vladimir Fortov from the Russian Academy of Science (RAS), member of the FAIR Council. Professor Bock receives this high-ranking award for his outstanding achievements in the field of heavy ion research.

Award for Christian Graeff

The GSI biophysicist **Dr. Christian Graeff** has been honored for his scientific achievements with the Günther von Pannewitz Award of the German Society of Radiation Oncology (DEGRO). The award was presented in recognition of his research on the use of ion beams to treat cardiac arrhythmia. The award, which is endowed with €1,000, recognizes outstanding research work in radiation therapy for non-malignant diseases

Theory PhD Award for Antje Peters

Dr. Antje Peters has been honoured with the PANDA Theory PhD Prize 2018 for her doctoral thesis about lattice QCD calculations for open-flavor four-quark systems at the Goethe University Frankfurt. It was the first time the award was presented by the PANDA collaboration. It will in the future honor the best PhD thesis connected with the PANDA physics programm annually. The award includes a certificate and €200 prize money.

Prestigious award for Nasser Kalantar-Nayestanaki

Professor Nasser Kalantar-Nayestanaki (l.) has been named a Knight of the Order of the Netherlands Lion. This honor, which is the oldest and highest order of chivalry open to civilians in the Netherlands, was awarded in recognition of his achievements in the field of nuclear research and his social commitment. Kalantar-Nayestanaki is a member and a former spokesperson of the international NUSTAR collaboration and the Vice President of the GSI Exotic Nuclei Community (GENCO).

Zimanyi Medal for Hannah Petersen

Professor Hannah Petersen has been awarded the Zimanyi Medal of the Hungarian Academy of Sciences. The award is in honor of her work on relativistic heavy ion collisions. The young researcher has been the leader of a Helmholtz Young Investigators Group at GSI since 2012 and is a professor teaching at the Goethe University in Frankfurt.

Björn Jonson receives Russian Lomonosov Gold Medal

Professor Björn Jonson (l.) has been rewarded with the highest award of the Russian Academy of Sciences (RAS), the Lomonosov Gold Medal. Jonson is a professor at the Chalmers University in Sweden. His longstanding cooperation with GSI/FAIR include leading the HALO collaboration and being spokesperson of the NUSTAR collaboration. He was also deputy spokesman of the R3B collaboration and is currently chair of the R3B Scientific Board as well as of the NUSTAR Council.