



SCIENCE BRIDGE – CONNECTING PEOPLE AND KNOWLEDGE

A Model for Scientific and Technological Cooperation

>> The **Science Bridge** collaboration model is a thriving project, which usually develops from a small start – two scientists who agree to work together – into a major bilateral collaboration: GGSB represents a first exemplary case. It not only provides scientific and educational prospects, but also stimulates cultural relationships, and all partners involved hope that this collaboration model will continue to develop in the future. <<

PREFACE

In striving for a knowledge-based society in our modern world, science plays an outstanding role as a major driver for progress and enabler of economic growth.

An international approach is usually necessary, not only because one community or even nations alone may not be able to raise the required resources, but also in order to accumulate the expertise needed for a successful implementation of a complex and challenging project.

Another aspect is that partners with different starting points and areas of strength may want to join forces together in addressing a common objective for their mutual benefit.

One such example is the Georgian-German Science Bridge (**GGSB**), which is a model of a symbiotic voluntary relationship that connects a consortium of four Georgian Universities and a couple of institutes of Forschungszentrum Jülich (**FZJ**), which are also affiliated to various German universities.

The following pages introduce the Science Bridge concept in general and the GGSB in particular. In addition, it outlines the scheme of SMART | Labs, which are supposed to offer an opportunity to the smartest young (Georgian) scientists to return home, after having received part of their education and initial research experience abroad, in order to develop the aforementioned knowledge society in their home country.



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SCIENCE BRIDGE – CONNECTING PEOPLE AND KNOWLEDGE

Based on a common scientific interest, a Science Bridge provides two-way connections between individual researchers or groups thereof, scientific organisations or even countries and geographical regions.

The objective is to bring together people, to build networks via various common activities and start scientific collaborations. In addition to research and technology development, the Science Bridge offers lectures and workshops to students and promotes the brightest through specific fellowship programmes. It links diverse cultures, thereby fostering a mutual understanding and appreciation.



Three Pillars to Success



JOINT RESEARCH

Use existing infrastructures and invite people to join scientific projects, plan and build new research infrastructures and use them for common research. This research comprises the grand challenges of contemporary science, ranging from fundamental questions like “Why do we exist at all?” and “How does Nature make particles and nuclei?” to societal challenges concerning the health of people and their food supply as well as sustainable energy production and environmental issues at large.

EDUCATIONAL TRAINING

Identify talented young scientists and students and help them to find their way by different educational training programmes; implement Cotutelle de these¹ programmes for doctoral theses at a home university in one country and a partner university abroad.

Implement tailored fellowship programmes.

KNOWLEDGE TRANSFER

Establish joint labs to return well-educated excellent young scientists in the fields of cooperation, thereby building up hubs on different thematic areas.

¹ Cotutelle programme is a bi-national doctoral programme to secure academic links to both participating countries and to maintain a research focus that is strongly connected to the countries.

GEORGIAN-GERMAN SCIENCE BRIDGE GGSB



Triggered by common research projects, Forschungszentrum Jülich founded in cooperation with Tbilisi State University (**TSU**) the Georgian-German Science Bridge in 2004. Till date three further Georgian universities joined the GGSB: Agricultural University of Georgia (**AUG**), Georgian Technical University (**GTU**), and Ilia State University (**ISU**) (see chapter: The GGSB Partners). The GGSB partners have promoted a Bachelor, a Master and a PhD study programme and created opportunities for the young scientists to return to their home country after graduation. Both sides benefit from this programme: highly motivated and well-educated students from Georgia come to Jülich and conduct research in an environment, equipped with first-class laboratories and research infrastructures together with globally recognized, largely international research teams. Now, after almost 15 years of cooperation in the framework of the GGSB, besides research a fixed recurrent lecturing programme (Summer Schools and Autumn Lectures) is operated.



How did it Start and Develop?

In 1992, the first contact was established between two scientists: Otto Schult, (at that time director of the Institute for Nuclear Physics of Forschungszentrum Jülich) and Mikheil Nioradze (Director of the High Energy Physics Institute of Tbilisi State University (**HEPI TSU**)). After elaborate preparations and intense scientific exchange, in 1995 TSU first joined the “ANKE” project, an international collaboration in the research field of Hadron Physics at the Cooler Synchrotron (**COSY**). A few years later, in 1998, the parties signed the first agreement for a mutual collaboration. The contribution made by TSU was to construct and deliver the so-called “Cherenkov counters”, a detector system for the long-term use at the ANKE spectrometer. Furthermore, it was agreed to exchange scientists and co-workers as well as materials and equipment necessary for carrying out the joint research. Later on TSU joined the PAX and the JEDI-collaborations, and in 2004, the collaboration was ready to go the next level – the Science Bridge was born at the jointly organised Caucasian-German School and Workshop on Hadron Physics in Tbilisi.



Acknowledgment:

In 1996, Dr. Andro Kacharava, a Georgian physicist educated at TSU, visited the Forschungszentrum Jülich for the first time. In 2001, he started to work for the Institute for Nuclear Physics. Without his engagement and enthusiasm, the GGSB would never have been so successfully developed. He is the main driving force of this collaboration.

<http://collaborations.fz-juelich.de/ikp/cgswhp>



1992

First contact

Mikheil Nioradze and Otto Schult



1995

TSU joined “ANKE” Project



1998

Cooperation Agreement



2004

1st CGSWHP meeting

This workshop was supported by UNESCO regional bureau for Science in Europe. 70 participants from which one-third were students attended the workshop and it was the largest physics gathering held in Georgia since the country became independent in 1990. The CERN Courier highlighted this event that time as a great success and step forward.

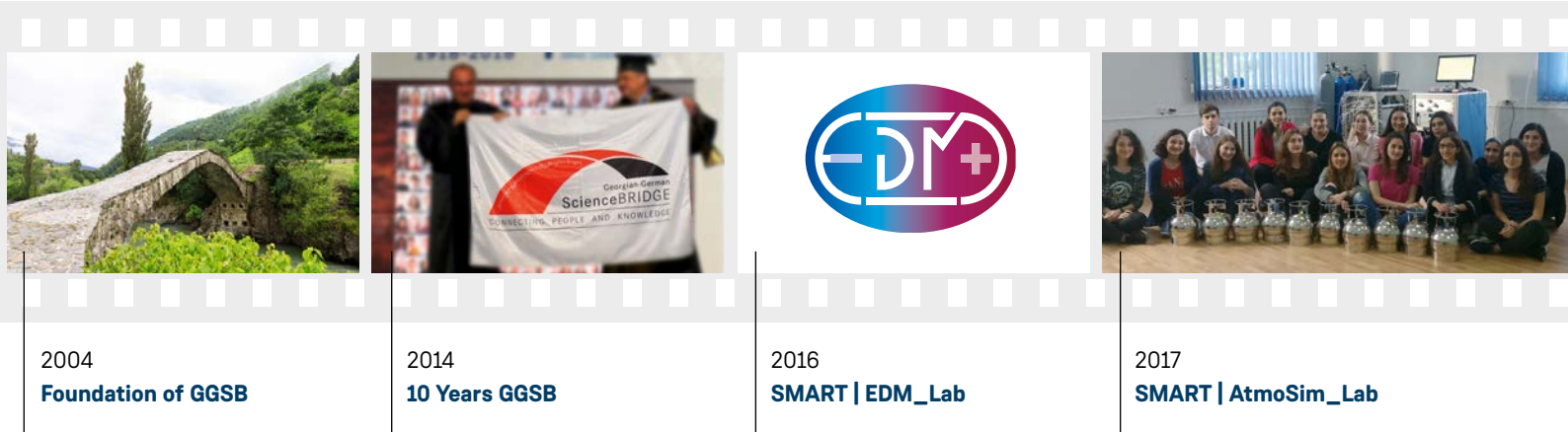
Two years later, in 2006, the next workshop in the framework of the Georgian-German Science Bridge on “Spin in Hadron Physics” followed. Again 70 participants attended, coming from 9 different countries. From that time onwards more institutes from the Forschungszentrum Jülich joined the collaboration and every other year workshops and summer schools were conducted. In 2008 however the event was cancelled due to the conflict between Russia and Georgia.

Till date 5 institutes of Forschungszentrum Jülich, active in nuclear and particle physics, analytics and engineering, neuroscience and medicine, climate research, and neutron science are committed to the GGSB cooperation. (Very recently, Jülich’s Institute of Bio- and Geosciences (**IBG-2**) showed interest to join the GGSB.) From Georgia the TSU, GTU, ISU and AUG became

<http://cerncourier.com/cws/article/cern/29204/4>

partners. The mutual activities have been extended intensively as we now offer workshops and lecturing programmes regularly. A student exchange programme was implemented in 2010 and extended in 2015. Forschungszentrum Jülich and the Shota Rustaveli National Science Foundation of Georgia (SRNSF) equally finance this programme. Many students have been educated since then.

A major highlight was the agreement between the Georgian Ministry of Education, Science, Culture and Sport (MES) and Forschungszentrum Jülich in 2016 to found so-called SMART | Labs (see chapter: SMART | Labs: Options to Return to Homeland). These labs are supposed to offer opportunities to the smartest young (Georgian) scientists to return home, after having received part of their education and initial research experience abroad. As at this day, two SMART | Labs have been opened; financed by the MES and supported by FZJ through equipment donation and providing access to its infrastructure.



2004
Foundation of GGSB

2014
10 Years GGSB

2016
SMART | EDM_Lab

2017
SMART | AtmoSim_Lab

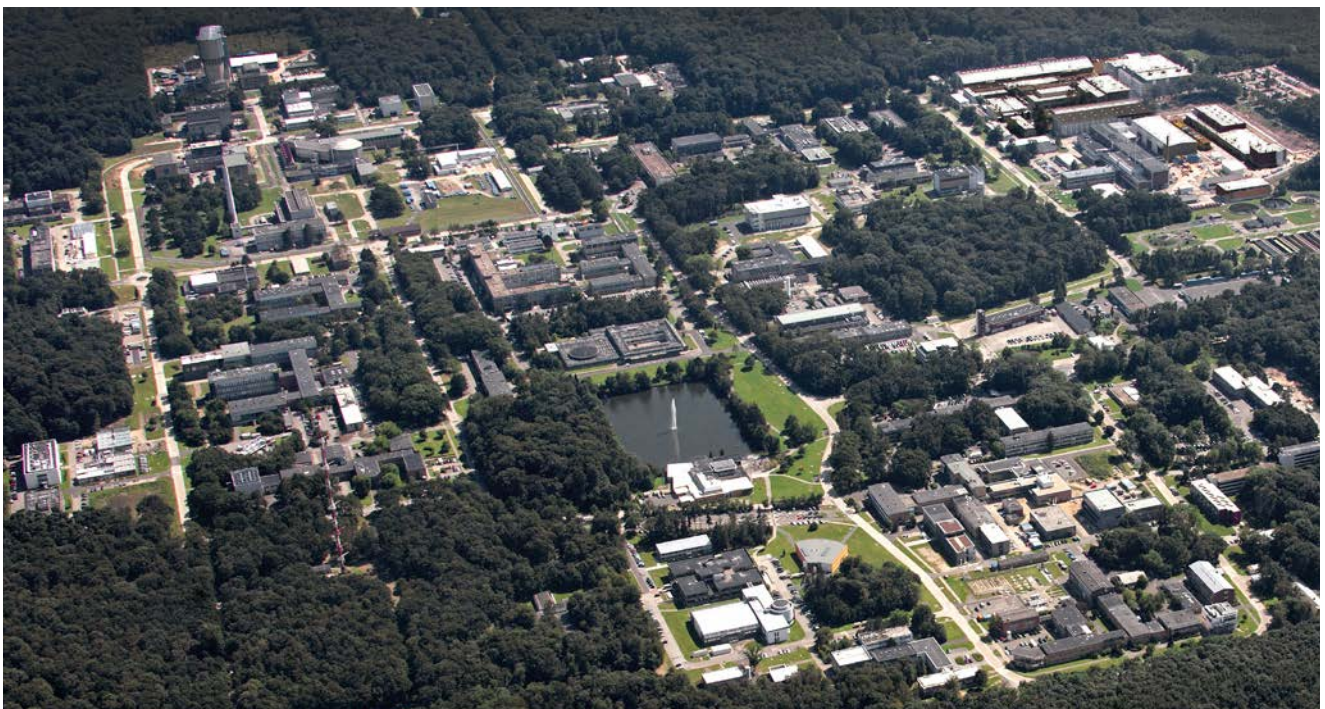
The GGSB Partners – in Germany

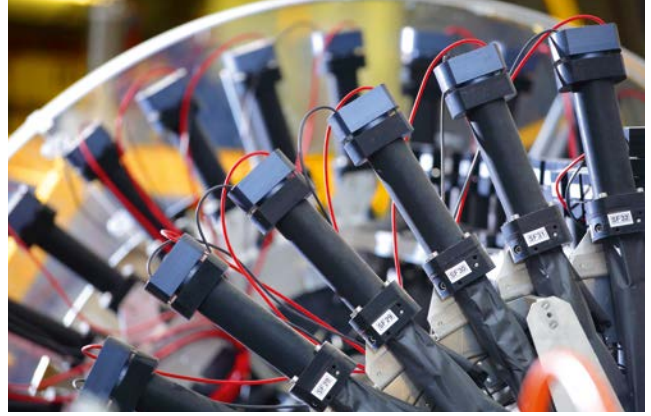
Forschungszentrum Jülich – The Institutes Involved

Forschungszentrum Jülich (**FZJ**) makes vital contributions to solving major challenges facing society in the fields of information, energy, and bioeconomy. It focuses on the future of information technologies and information processing, complex processes in the human brain, the transformation of the energy system, and a sustainable bioeconomy. FZJ develops simulation and data sciences as a key research method and makes use of large, often unique, scientific infrastructures. Its work spans a range of topics and disciplines and it exploits synergies between the research areas. With close to 6000 employees, Jülich – a member of the Helmholtz Association of German Research Centres (HGF) – is one of Europe's large research centres.

Five Institutes of Forschungszentrum Jülich committed to the GGSB cooperation: Institute for Nuclear Physics, Institute of Energy and Climate Research, Institute of Neuroscience and Medicine, Jülich Centre for Neutron Science and Central Institute of Engineering, Electronics and Analytics. GGSB is specifically supported by the Board of Management, in particular by Professor Sebastian M. Schmidt.

<http://www.fz-juelich.de>





Institute for Nuclear Physics (IKP)

The successful scientific cooperation between the Institute for Nuclear Physics (**IKP**) of Forschungszentrum Jülich and the High Energy Physics Institute of Tbilisi State University (HEPI TSU) dates back to late 1990's with a first agreement on "Joint Research Activities" signed on September 17, 1998. Based on the long-term and fruitful cooperation and given the new opportunities and upcoming large-scale projects in Germany, the collaboration was expanded to include other institutes of FZJ and Georgian universities (see below), which justifies the GGSB concept.

IKP is conducting basic research in the fields of nuclear and elementary particle physics. The physics programme addresses two big questions of modern physics, namely the matter-anti-matter asymmetry of our universe and a basic understanding of the building blocks matter is comprised of. The major part of the experimental programme is conducted at the in-house Cooler Synchrotron and storage ring COSY.

IKP and the Georgian partners agreed to continue their scientific cooperation in the field of fundamental particle and nuclear physics, which comprises existing projects as well as future ventures, and includes the following items:

- Jülich Electric Dipole moment Investigations (**JEDI**): Performing research and development (R&D) for accelerator components and measurements equipment, in particular for the design, construction and operation of a dedicated high efficiency polarimeter system for an electric dipole moment (**EDM**) search of charged particles. Undertaking joint preparatory experiments at COSY including a precursor EDM experiment; conducting R&D work for the design of a high precision EDM ring (prototype and final one) for protons and deuterons.
- Facility for Antiproton and Ion Research (**FAIR**): Contributing to developments for the High Energy Storage Ring (**HESR**) and the internal detector system for PANDA experiment; performing R&D for the Polarized Antiproton Experiment (**PAX**).
- Theory: Supporting the motivation, analysis and interpretation of the JEDI measurements at COSY and the upcoming FAIR experiments.

IKP and the Georgian partners agree to foster students exchanges by setting up Internship-, Master-, and PhD programmes together with German Universities (Aachen, Bonn, Cologne), in particular to support Georgian PhD students by preparing agreements between Georgian and German universities within the so-called Cotutelle programme. In fact, one successful example was already realized by the TSU and the University of Cologne (Zara Bagdasarian, 2016).

Till date, about 30 students have participated in the internship programme with IKP, around 10 Master theses were conducted and 6 PhDs were accomplished.

IKP initiated dedicated summer schools and autumn lectures as well as organised topical workshops and conferences both at FZJ and in Georgia to present and discuss recent results and to plan further cooperation.

There are also examples of IKP supporting Georgian scientists in common research and in the exchange of scientific components, in particular for the SMART | EDM_Lab (see chapter: SMART | EDM_Lab).

<http://www.fz-juelich.de/ikp>





Institute of Energy and Climate Research (IEK)

The Institute of Energy and Climate Research (**IEK**) investigates modern energy conversion technologies within the framework of climate and environmental protection. **IEK-8** of the Forschungszentrum Jülich has been one of the leading institutions in the field of atmospheric chemistry for more than 40 years. The research of IEK-8 focuses on key physical and chemical processes within the troposphere, which determine the trace gas composition of the atmosphere. The institute's research activities comprise (1) the emission of trace gases from ground sources, traffic, and industries, (2) the photo-chemical transformation of trace gases within the atmosphere and (3) the distribution of reactive substances by transport processes. Investigations include global, long-term observations of atmospheric trace gases, photochemical processes determining the self-cleansing efficiency of the atmosphere, as well as the production and ageing of aerosols and their impact on air quality, health, and climate.

The Institute of Energy and Climate Research and the Tbilisi State University agreed to continue their scientific cooperation in the field of atmospheric sciences and environment. This encompasses existing projects as well as future ventures, and includes the following items:

Numerics of forward and inverse modelling of atmospheric models:

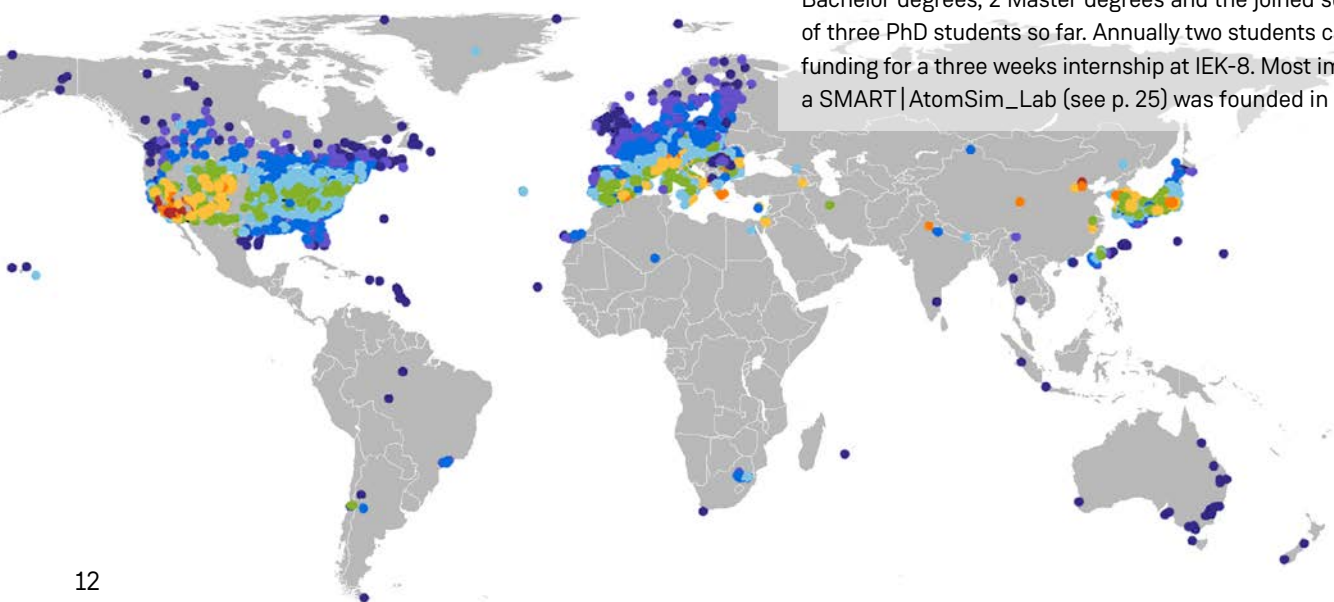
- Performing research and development (R&D) on the discretization of icosahedral grids;
- Performing R&D on data assimilation with adjoint atmospheric modelling, including preconditioning and minimization for variational methods;
- Performing R&D on numerical solution of stochastic differential equations of atmospheric processes.

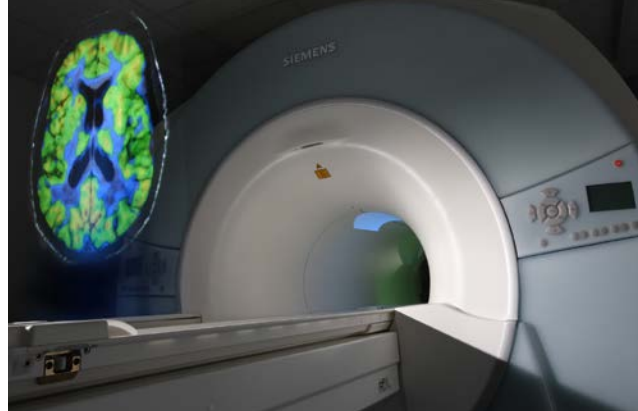
Development and application of specific analytical techniques for atmospheric process understanding:

- Performing R&D on enantioselective processes of chiral pollutants in the environment and atmosphere;
- Quantitative characterization with various laboratory methods;
- Development and application of micro- and nanoanalytical techniques for studying of atmospheric trace compounds

Within the concept of the Georgian-German Science Bridge (GGSB), several important cooperation projects between the IEK and TSU departments of Physical and Analytical Chemistry, and Numerical Analysis and Computational Technologies have been initiated and performed. In the seasonal school "Atmospheric chemistry and modelling" which was held in Tbilisi in 2016 and funded by SRNSF, 65 participants were attracted. The cooperation in atmospheric science has resulted in 4 Bachelor degrees, 2 Master degrees and the joined supervision of three PhD students so far. Annually two students can receive funding for a three weeks internship at IEK-8. Most importantly, a SMART|AtomSim_Lab (see p. 25) was founded in 2017.

<http://www.fz-juelich.de/iek>



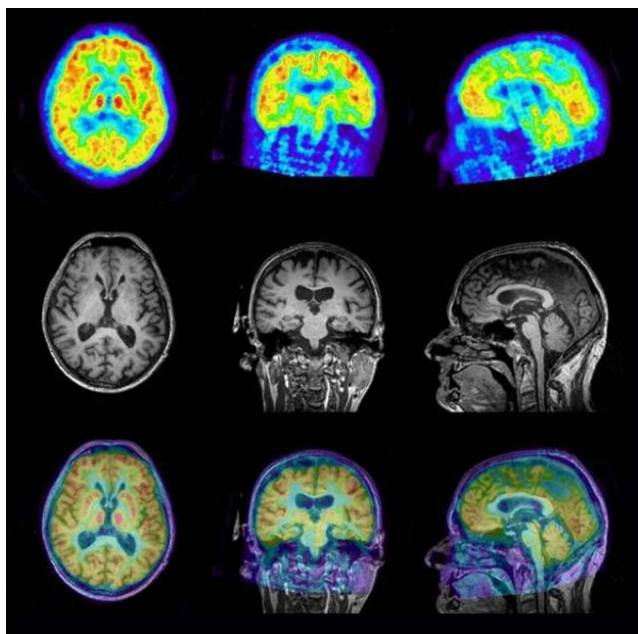


Institute of Neuroscience and Medicine (INM)

The Institute of Neuroscience and Medicine (INM) in FZJ provides a worldwide highly reputed research in neuroscience and a unique environment to support breakthrough discoveries. The research and development activities of the Medical Imaging Physics division (INM-4) of the Institute of Neuroscience and Medicine concentrate on the development, experimental validation and the clinical implementation of novel brain imaging methods. The focal points comprise the development of novel methods in the area of ultra-high field Magnetic Resonance Imaging (MRI), Magnetoencephalography (MEG) and the development of hybrid imaging combining MRI with Positron Emission Tomography (PET).

The researchers of the INM-4 develop, operate and maintain the scanners of the INM. Among others, INM-4 runs internationally unique imaging equipment such as the Ultra-High Field 7T Magnetom Terra and Hybrid MR-PET 9.4-Tesla magnetic resonance scanner.

Additionally, in cooperation with other divisions of the Institute and external researchers, numerous scientific studies into various neuroscientific problems are conducted. The developed advanced approaches should, on the one hand, improve our general understanding of the complex relationships between the brain microarchitecture, global connectivity, and function in neurodevelopment, ageing, and pathology. On the other hand, they are expected to contribute to the establishment of improved diagnostic tools and risk estimators for diseases in the clinical practice.



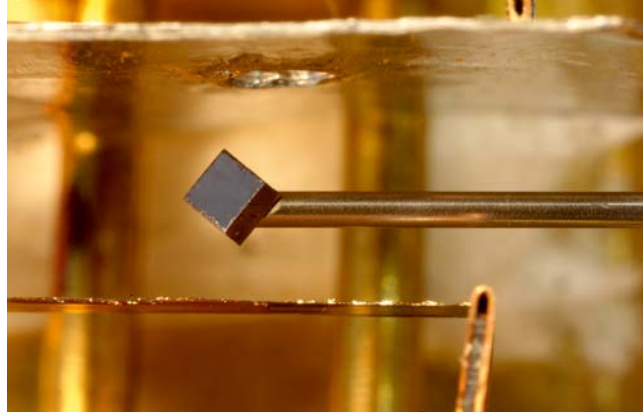
At the Nuclear Chemistry division (INM-5), cutting-edge radiochemistry is performed to obtain diagnostic probes for clinical PET imaging. These smart imaging probes enable to discover brain function as well as pathophysiological processes at the molecular level. Thus, the institute developed a brain tumour-imaging agent, which allows to visualize the exact dissemination of brain tumour tissue. This information is used by the surgeon to remove the tumour or by the radiotherapist for radiation treatment planning.

Research work focuses mainly on organic preparative chemistry and the development of novel ^{18}F -labelling strategies. These novel methods allow to produce PET probes for the elucidation of brain function and structure. Furthermore, the top-level infrastructure with GMP facility for radiopharmaceutical manufacturing and the high performance cyclotron for radionuclide production facilitates the implementation of human studies to elucidate brain function and structure.

Within the concept of the “Georgian–German Science Bridge” (GGSB), several important cooperation projects between the Institutes of FZ, including INM-4 and INM-5, and Georgian universities have been initiated and performed. In particular, both INM Institutes contributed to the series of “Autumn Lectures” organised by the GTU in Tbilisi (2013, 2015) devoted to Medical and Nuclear Physics.

As initiated by the above agreements, 8 Georgian students were invited and stayed several times for a few-week internship at the INM-4. These students utilized the opportunity to get familiar with the unique research environment of INM-4 and to gain experience in the field of medical physics, which represents a new modern field of education in GTU. Preparations for further SMART|Labs are being discussed. Furthermore, several students won prestigious fellowship grants in the frame of the “JÜLICH-GEORGIA Joint Call for Master and PhD Student Exchange Programme” (“JÜLICH-SRNSF Fellowship Grant”).

<http://www.fz-juelich.de/inm>



Jülich Centre for Neutron Science (JCNS/PGI)

JCNS develops and operates neutron scattering instruments at some of the best neutron sources worldwide. JCNS maintains a dedicated user programme for instruments at the MLZ in Garching, Germany, the ILL high-flux reactor in Grenoble, France, and the SNS Spallation Source in Oak Ridge, USA. In-house research focuses on quantum materials, correlated electron systems, and nanomagnetism as well as on soft matter and biophysics. Within these areas of expertise, JCNS offers expert support at world-class instruments including a specialized sample environment and ancillary laboratory access for external users from science and industry.

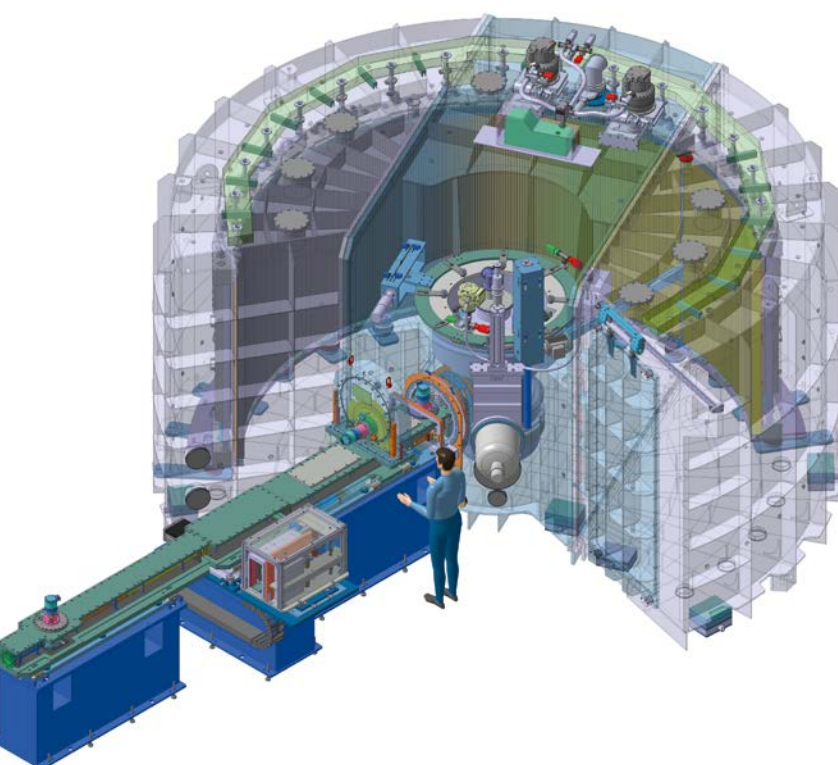
FZJ (JCNS/Peter Grünberg Institute for Quantum Materials and Collective Phenomena (**JCNS-2/PGI-4**)) and the Georgian universities (TSU, ISU) agreed to continue their scientific cooperation in the field of condensed matter physics and scattering methods.

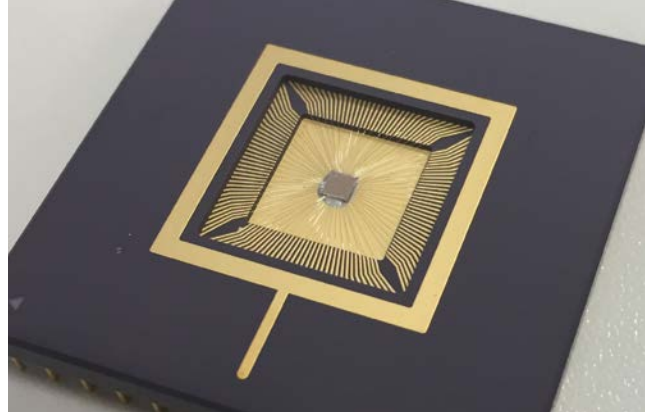
This encompasses existing projects as well as future ventures, and includes the following items:

- Application of grazing incidence scattering techniques on thin films and nanostructured systems.
- Development and microscopic understanding of quantum materials and systems for information technology and applications in energy conversion.

In the context of the Georgian-German School and Workshop in Basic Science (GGSWBS) JCNS scientists gave lectures on soft and condensed matter physics in Tbilisi and met students for project discussions. On the other hand, Georgian scientists have visited the JCNS-2/PGI-4 institute for project and cooperation discussions several times. Georgian students (2 PhD from TSU, 1 PhD from ISU and 1 Master student from GTU) worked on their thesis projects on the topics listed above in the frame of the “JÜLICH-GEORGIA Joint Call for Master and PhD Student Exchange Programme”.

<http://www.fz-juelich.de/jcns>





Central Institutes of Engineering, Electronics and Analytics (ZEA)

In cooperation with scientists from other institutes at Forschungszentrum Jülich, the Central Institute of Engineering, Electronics and Analytics (**ZEA**) develops devices, experiments, processes, analytical procedures and equipment, measuring and control facilities, and detector systems as well as computer-assisted tools and imaging techniques required for cutting-edge research that are not available on the market.

The institute advises and supports internal and external partners and customers in all technology-related matters. It develops methods suitable to address new challenges. ZEA supports projects from the original idea up to the final product.

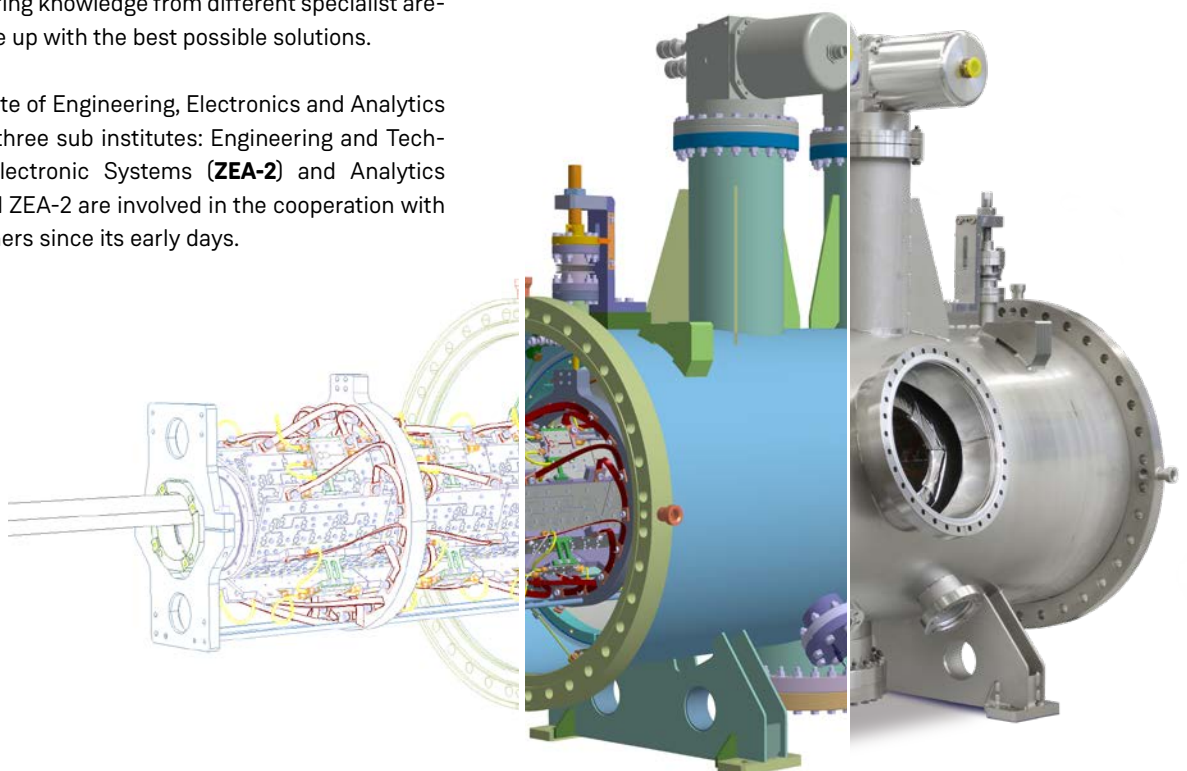
For over 40 years, ZEA developed and produced customized high-tech systems, instruments and processes for industry and cutting-edge research, as well as offered a comprehensive, one-stop range of services, from project planning, simulation and feasibility studies right through to the development, production and installation of the final product.

The interdisciplinary project teams - made up of engineers, physicists, material scientists, automation specialists as well as manufacturing experts and technical staff - bring together extensive engineering knowledge from different specialist areas in order to come up with the best possible solutions.

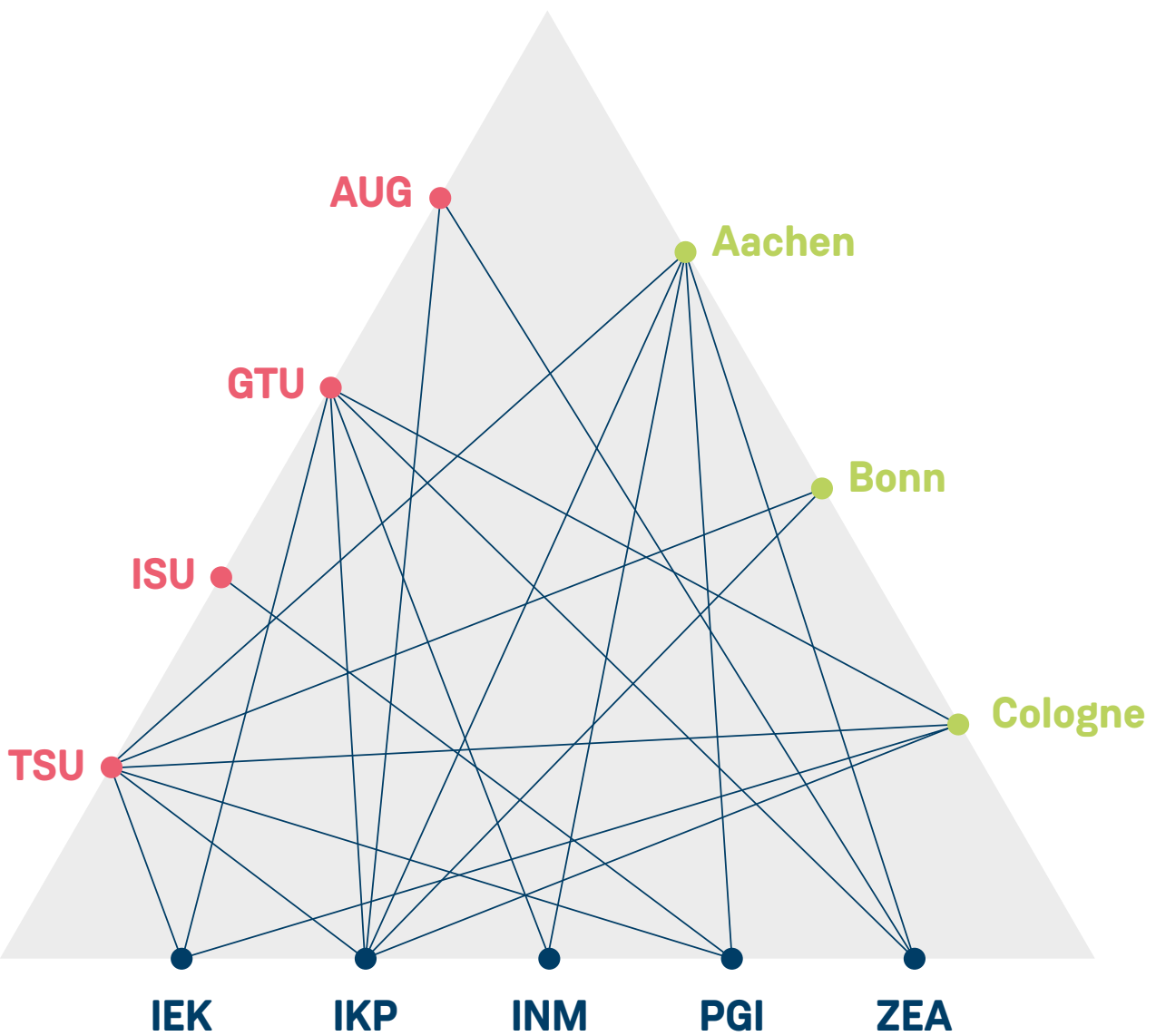
The Central Institute of Engineering, Electronics and Analytics (ZEA) consists of three sub institutes: Engineering and Technology (**ZEA-1**), Electronic Systems (**ZEA-2**) and Analytics (**ZEA-3**). ZEA-1 and ZEA-2 are involved in the cooperation with the Georgian partners since its early days.

The directors of ZEA-1 and ZEA-2 with involved scientists representing physics, electronics, simulation science and material sciences participated at the workshops, the schools and the lecture series in Georgia and in Jülich. Many students from the four Georgian universities were hosted at ZEA for several weeks and months. Delegations from ministries and from the partner universities are regularly touring ZEA labs during their visits to Forschungszentrum Jülich. In addition, the Georgian students and scientists visiting other institutes like IKP, INM or IEK enjoy the cooperative partnership support of ZEA as the Jülich scientists do.

<http://www.fz-juelich.de/zea>



The GGSB Partners – in Georgia



- The Georgian Consortium
- Participating German Universities
- Involved Institutes of Forschungszentrum Jülich



Ivane Javakhishvili Tbilisi State University (TSU)

The first-ever national university in the Caucasus was opened in 1918 laying the foundation for a European-type higher school in Georgia, based on Georgian educational traditions. **TSU** is one of the biggest higher educational institutions by its scales in the Caucasus. About 22.000 students are undergoing studies at seven faculties of TSU today. Annually, TSU implements more than 200 local and international scientific grant programmes. The university is ranked 359th in ‘Best Global Universities Rankings 2018’. Based on the close cooperation with foreign universities, TSU students have the opportunities to participate in exchange and joint international educational programmes and are able to gain double academic degrees.

In the framework of the Georgian-German Science Bridge, the cooperation between TSU and FZJ introduced a new dimension of internationalization by means of combining joint research, educational training and knowledge transfer as a unified and comprehensive approach. The High Energy Physics Institute of TSU (HEPI TSU) was the first institution from Georgia who started the cooperation with Jülich’s Institute for Nuclear Physics (IKP).

Looking back to a successful common history of more than 20 years, the cooperation between IKP and HEPI TSU laid the cornerstone of what is now called the Georgian-German Science Bridge (GGSB).



HEPI TSU scientists became members of the ANKE experiment at the Cooler Synchrotron COSY at IKP right after the start of the collaboration, and their contribution have been very visible and valuable indeed. Later they joined the PAX-at-COSY collaboration, and more recently they have become involved in the project called JEDI (Jülich Electric Dipole moment Investigations). For the latter one, it is expected to be a collaboration with high impact to TSU.

Till date, more than 30 joint scientific papers and, in addition, conference contributions and proposal submissions as well as 6 dissertations and 10 Master theses, the exchange of about 50 students and senior scientists in the framework of internships and DAAD programmes have been carried out. A recent highlight is the successful realization of a first common PhD within the so-called “Cotutelle” programme between the University of Cologne (Germany) and TSU.

Today TSU is the home of two well-equipped SMART | Labs: SMART | EDM_Lab and SMART | AtmoSim_Lab. They both were established in cooperation with FZJ. The TSU faculties’ departments cooperate with the FZJ institutes IKP, IEK, INM, ZEA and JCNS. Bachelors, Masters and doctoral students are jointly trained and research topics are tightly connected. The extension of the cooperation is envisioned between TSU and FZJ institute IBG. Discussions have started to establish a next SMART | Lab at TSU, dedicated to nuclear medicine and chemistry.

<https://www.tsu.ge/en/>



Georgian Technical University (GTU)

Georgian Technical University (GTU) is one of the biggest educational and scientific institutions in the South Caucasian region. Founded in 1922, GTU is a leading engineering higher educational institution and powerful scientific centre, which comprises 12 faculties (covering Engineering, Technology, Humanities, Law, Business, and Social Sciences), 71 departments, 127 educational scientific centres, and 17 scientific-research institutes. GTU is a full member of various international networks, including EUA, ITU. GTU joined the Bologna process. It has partner relationships with up to 58 local and 75 international research and scientific-educational organisations. GTU educational-scientific activities are funded by the local and international scientific organisations and funds, including TEMPUS, Erasmus Mundus, FP7, and Erasmus+. GTU participates in Millennium Challenge Corporation (MCC) project for STEM Higher Education Development in Georgia. STEM programmes include Electrical Engineering, Computer Engineering, Computer Science, Chemical Engineering and Civil Engineering fields at GTU. GTU has advanced partnerships in the fields of education and research with the world's leading organisations, such as KEK (Japan), Forschungszentrum Jülich GmbH (Germany), CERN (Switzerland), and JINR – Joint Institute for Nuclear Research (Dubna, Russia).

The university currently has almost 19000 Bachelors-, more than 1200 Masters- and 640 PhD-Students; it comprises around 1200 Academic Personnel, and a similar number of professors.

The Georgian Technical University (GTU) together with Forschungszentrum Jülich (FZJ) have initiated a project called “Autumn Lectures” which is intended to be a bi-annual series, with the first one being held at GTU in October 2013. A second International School: „Autumn Lectures in Tbilisi – Nuclear Physics for Medicine“, October 2015, and a third International School: Autumn Lectures (“QUALI-Start-Up Science Lectures”), held in Jülich at the Forschungszentrum in September 2017.

8 PhD and Master Students from GTU received a fellowship grant in the framework of the “JÜLICH-GEORGIA Joint Call for Master and PhD Student Exchange Programme”. Currently 4 more PhD and 2 Master students from GTU are in the Institute of Neuroscience and Medicine (INM-4, Medical Imaging Physics).

<http://gtu.ge/Eng/>





Ilia State University (ISU)

Ilia State University (**ISU**) is a flagship public research and comprehensive higher education institution in Georgia that was established in 2006 as a merger of six different institutions, each having a long history and a diverse institutional profile. Its schools offer distinctive training in their respective direction and in-depth research opportunity in social sciences, business, law, humanities, life sciences, earth sciences, and hard sciences. Teaching, especially at graduate level, is tightly integrated with scientific research and the nexus between these two is very strong. The leadership remains open to innovative teaching and learning programmes and supports research initiatives to finance research activities (significant allocation for research as part of its annual budget), justly occupying the top research citation index in Georgia. With the highest competition rate for PhD programmes in the nation, over 15,000 students, around 1000 highly qualified academic staff, and with renovated research infrastructure in several Georgia's regions (including 30 large and small scale research institutes, centres and stations), ISU has become one of the

most desirable universities to study and work for in the country. Supporting international education training of young researchers is one of the key priorities of ISU. In 2017 Ilia State University established interdisciplinary International Doctoral School which has a strong focus on international exchange and mobility, especially on Cotutelle-based Ph.D. projects leading to double or even multiple degrees. In September 2017 two of the ISU students successfully participated in QUALI-Start-Up Science Lectures in Germany, one of them did a 6-week internship at Jülich's IBG-3 (Agrosphere) in March/April 2018. Within the frame of the joint educational research programme of Shota Rustaveli National Scientific Foundation and FZJ, in 2014 a project - "Transfer processes in Nanostructured Thermoelectricity" was financed and implemented.

<http://iliauni.edu.ge/en/>





Agricultural University of Georgia (AUG)

AUG, originally established in 1929 as a State University was privatised in 2011 due to its commitment to excellence and its rapid progress. AUG is now recognized as one of the leading research universities in Georgia. The university is offering to 3000 students' bachelors, masters and PhD programmes in Agricultural and Natural Sciences, Technology and Engineering and Business Administration. In 2015 AUG joined the Consortium of Georgian Universities, cooperating with FZ Jülich within the concept of the "Georgian-German Science Bridge" (GGSB). In 2017 the Department of Electrical and Computer Engineering (ECE) became a member of the international JEDI Collaboration (an IKP/FZJ project of fundamental science, in close cooperation with ZEA and RWTH Aachen and worldwide partners). AUG is interested in research and development work for the design and construction of a high efficiency polarimeter system for an electric dipole moment (EDM) search at the Cooler Synchrotron storage ring (COSY). The topics of interest include detector and target design and construction, including items related to electronics and readout systems. In particular, two Masters Students are the members of the research group at the SMART|EDM_Lab of TSU and working on the above-

mentioned topics. The IKP and ZEA institutes are offering access to students to world-leading scientific infrastructure at FZJ; training by experienced scientist and professors, dedicated lecture courses at regular Summer Schools ("GGSWBS"), Autumn Lectures ("QUALI-Start-Up") jointly organised by FZJ and SRNSF, and involvement in Masters and PhD programmes. The extension of the cooperation is envisioned between the AUG departments of Biology and Chemistry with the FZJ institutes of INM and IBG. Discussions have started to establish the next SMART|Lab at AUG, dedicated to Simulation, Engineering and Technology (SMART|SET_Lab).

<http://www.agruni.edu.ge/en>





Ministry of Education, Science, Culture and Sport of Georgia (MES)

The Ministry of Education, Science, Culture and Sport of Georgia (MES) aims at establishing modern and innovative educational and scientific environment in close cooperation with civil society. The Ministry promotes close cooperation of the higher education and scientific institutions, recognizing the crucial role of the link between scientific research and the higher education. Therewith, focal point of the development of the Georgian higher education system is set through the advancement of the quality of higher education institutions. The Ministry advocates freedom of choice, fair competition, equal opportunities, civil integrity, and respect for cultural identity. The Ministry promotes acquisition and development of knowledge and skills necessary for social success and self-realization. Therewith, the Ministry recognizes the importance of internationalization of higher education and sets this goal as one of its leading priorities.

The MES is impressed by the commitment of the Forschungszentrum Jülich in Georgia and financially supports the activities between the Georgian universities (consortium) and FZJ. In 2016, the Science Minister, Tamar Sanikidze, together with a delegation of the Shota Rustaveli National Science Foundation of Georgia (SRNSF) visited the Forschungszentrum Jülich and agreed on the establishment of the so-called SMART|Labs at the Georgian Universities.

SMART|Labs will be founded under the following intentions:

- Each SMART|Lab will be located at one of the consortium universities, which outlines the general scope of the planned topical laboratories
- Each SMART|Lab will be headed by an outstanding young Georgian scientist returning back to Georgian science to ensure and intensify further educational and scientific exchange with scientists from JÜLICH
- Different SMART|Labs should cooperate as much as possible

For future SMART|Labs the following should always apply; they should:

- further develop Georgian frontier science and future technologies
- connect scientific and medical questions;
- have a strong technological application-based component;
- comprise approx. 3-5 scientists/engineers;
- be built around an outstanding young Georgian scientist;
- build strong ties to an international research facility;
- be supported with start-up resources by the partners involved

MES considers the SMART|Lab concept as a special cooperative targeted programme and is willing to support these long-term (> 10 years) research projects with financial resources operated by the SRNSF.

During a visit of the Science Minister, Prof. Mikheil Chkhenkeli, in June 2018, a Letter of Intent was signed by the partners in order to expand the collaboration to promote the education of young students along the line of Jülich's JuLab.

The ministry values this activity as a measure to improve the quality standards of scientific research and the education of students at the Georgian universities.



Shota Rustaveli National Science Foundation (SRNSF)

The Shota Rustaveli National Science Foundation of Georgia (**SRNSF**) is a Legal Entity of Public Law under the aegis of the Ministry of Education and Science of Georgia. SRNSF supports the development of Science, Technology and Innovation (**STI**) system in Georgia. The vision and strategy of the foundation is in line with Georgia's socio-economic development strategy – «Georgia 2020», the four-point governmental reform plan and the EU-Georgia Association Agreement requirements regarding the STI system development.

The strategic vision of the foundation is to promote Georgia's integration into the international STI system, and significantly contribute to rapid socio-economic development and welfare of the country and to establish the globally engaged Georgian scientific community.

Mission of the foundation is to support new generation of Georgian scientists, increase research potential in the scientific institutions and communities, support Georgian scientists' integration into the international scientific area by encouraging improvements in quality, highlighting importance innovative scientific research and enhancing competitiveness of the Georgian scientific community.



Goals and Priorities of the Foundation:

- supporting high quality scientific research in Georgia;
- promoting Georgian scientists' competitiveness and development of young scientists' potential;
- developing international cooperation in Science, Technology and Innovation system;
- promoting the diversification of Science, Technology and Innovation.

Following these objectives, the SRNSF signed an agreement with FZJ on an exchange programme for Masters and PhD students in 2010. The purpose of this programme is to:

- enable Georgian students access the partner's excellent research facilities of the partner organisation;
- to experience and conduct frontier research in fundamental and applied sciences;
- to assist the partner in recruiting the distinguished students from Georgian universities and prepare Masters and PhD theses for further progress of Georgian science;
- support Georgian scientists to return and share gained international experience at their home universities and research centres.

The aim is to provide Georgian Masters and PhD-students the opportunity to carry out their thesis at one of the institutes of FZJ, and to ensure long-term cooperation in the research fields of Mathematics, Information Technologies, Natural Sciences, Engineering Sciences, Life Science and Health.

This agreement has been extended for further five years in 2015. Highly motivated students, who participated in the FZJ workshop and lecturing programme are given the possibility to apply to this scholarship programme. With the given cooperation scheme the students are funded by both SRNSF and FZJ. Details and information about the funded projects in the frame of the programme can be accessed via this link: <http://rustaveli.org.ge/en/JULICH>.

SMART | Labs: Options to Return to Homeland



Public school at Abasha, Georgia, 2016

In 2016, both sides agreed to extend the research and training pillar and decided on the concept of so-called SMART | Labs: labs for outstanding young, well-educated scientists, allowing them to return to their home country, whereas SMART means Science, Medicine, Applied Research and Technology.

SMART | Labs will support the further development of the Georgian science system and is therefore funded by the Georgian Ministry of Education and Science; they involve the establishment of laboratory centres at Georgian universities for jointly defined scientific projects

They should further:

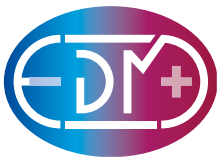
- address fundamental questions of science and challenges for society;
- have a strong application-oriented and technological component;
- consist of a small group of scientists, engineers and students, led by a distinguished young Georgian researcher, connected to a project at Forschungszentrum Jülich and
- ensure continuous communication, the effective use of the equipment/instruments purchased and, in particular, the scientific development of the researchers involved in the project.



The SMART | Labs are equipped with modern instrumentation by the partners to effectively carry out their activities and meet their (international) objectives within the project. Thematically differently oriented SMART | Labs should be internally linked in order to make best use of synergies at all levels.

SMART | EDM_Lab:

SMART | EDM_Lab started at TSU in September 2016: its science case is the matter/antimatter asymmetry of the universe, arguably one of the greatest puzzles of contemporary physics and cosmology. The corresponding project is a search for electric dipole moments of charged particles in storage rings, which is being pursued at the cooler synchrotron COSY of Forschungszentrum Jülich. The Georgian group under the leadership of Dr. David Mchedlishvili is heading the effort to build a precision polarimeter for observing the miniscule change of polarization direction in a beam of polarized protons (or deuterons) as a function of time due to an electric dipole moment (EDM). One additional objective is possible applications: in this case, the know-how acquired in building and operating the scintillator-based polarimeter might lead to new advanced positron-electron tomography (PET) scanners.



Dr. David Mchedlishvili

“ ... After being abroad for almost 10 years while doing my PhD and PostDoc, I was given a unique opportunity to return to my homeland and, at the same time, remain in the same scientific field, doing the same research. Moreover, the establishment of the SMART | EDM_Lab at Tbilisi State University (Georgia) gave me the possibility to build my own local team in my home university. I believe all these will help me in the future to scale-up my research and collaborations not only in Georgia but also worldwide.”



Dr. Irakli Keshelashvili

“ ... as a staff member of the Institute of Nuclear Physics at Forschungszentrum Jülich and head of the EDM-Lab since 2014, I am very pleased to cooperate with Georgian students and colleagues on a most challenging project called JEDI, which aims to find the reason for our very existence as being made from ordinary matter.”

SMART|AtmoSim_Lab:

A second lab, called SMART|AtmoSim_Lab, has been founded in October 2017, again at TSU. The AtmoSim_Lab is based on the collaboration between the Jülich Institute of Energy and Climate Research (IEK-8, Troposphere) and is dedicated to atmospheric research, including the chemical analysis of atmospheric pollutants, mathematical analysis of data taken and modelling of air pollution. Clearly, this is a much more pressing societal issue, given, e.g., the exhaust emissions of the cars in Tbilisi. That is why the city supports this research financially. Most of the initial equipment comes from the Jülich institute of climate and research. Dr. Giorgi Jibuti heads the lab. It is assumed that the results of the investigations will help to improve the air-quality in Tbilisi in the near- and medium-term future.



Dr. Giorgi Jibuti

“ ... SMART|AtmoSim_Lab gave me the possibility to perform research in a very interesting and new field of science: atmospheric chemistry. Now students have the opportunity to learn and research atmospheric chemistry hands-on. Their studies will not be limited to chemistry, but they include mathematics and informatics, which will help to evaluate collected data and help modelling and forecasting atmospheric contamination. In the end the results will help to get a better understanding of chemical processes in the atmosphere.”

SMART|AtmoSim_Lab is not only significant at academic level, but at societal level as well: regulatory bodies and organisations can receive competent opinions regarding air quality in Tbilisi (and in Georgia) and also recommendations on how to minimize atmospheric contaminations more efficiently.”

Further SMART|Labs

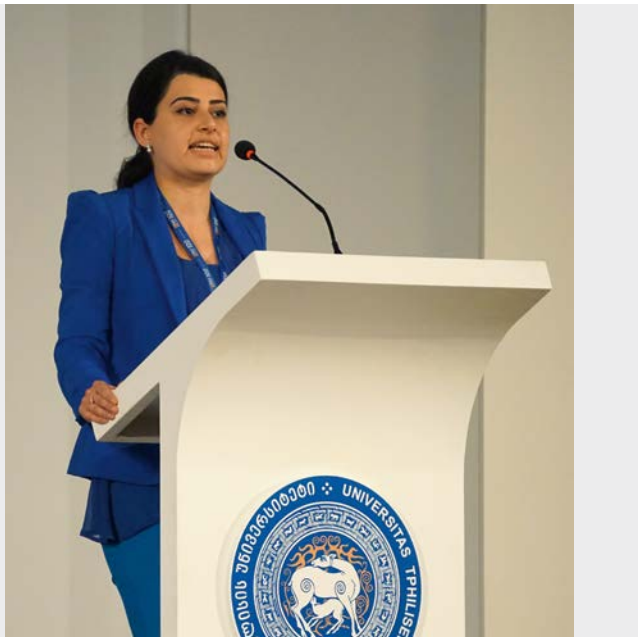
Currently, Georgian universities and the institutes of Forschungszentrum Jülich are in discussions regarding the implementation of further SMART|Labs in the area of medical imaging (SMART|MRI_Lab), for biomedical applications (SMART|BioMed_Lab) and in the area of simulations, engineering and technology (SMART|SET_Lab). These plans possibly include the involvement of further universities from the Georgian side as well as further institutes of FZJ.

We also envision a cooperation between schools (pupils, teachers) and the JuLab of FZJ in form of a SMART|SmR_Lab (School meets Research).

Achievements Made

Joint Research

Many scientific projects have been established in the area of nuclear and particle physics, atmospheric and climate research, neuroscience and medicine, neutron science and analytics and engineering. During the past years, more than 70 common scientific papers have been published in refereed journals. A few dedicated examples of achievements are given.



Zara Bagdasarian

"... Receiving PhD from University of Cologne (Germany) and Tbilisi State University (Georgia) has undoubtedly played a great role in the development of my career at this early stage. Since the graduation, I was selected to participate Nobel Laureate Meeting in 2016, was interviewed for the magazines called "Bild der Wissenschaft" and "American Scientist", and was invited to give a seminar at Columbia University and Oak Ridge National Laboratory (USA). I am currently a member of the Borexino collaboration, with the main research focus on solar neutrinos."

IKP-2 projects:

First hardware contribution (investment) from Georgian side was the so-called "Inclined Cherenkov Counters" for the ANKE-COSY experiment provided by TSU partner. The new type of detector system was proposed, designed, built, tested and manufactured in Tbilisi at High Energy Physics Institute of TSU. The device was implemented at ANKE spectrometer and used in several experiments. Irakli Keshelashvili was the first Georgian student who did his Masters (in 2001) and his PhD theses (in 2006) at FZJ. David Chiladze and David Mchedlishvili followed. Recently, Zara Bagdasarian was the first TSU student to receive a common PhD from TSU and University of Cologne (Cotutelle). Malkhaz Jabua received 2 PhDs, one from the University of Cologne and the other from the GTU.

Currently, the Georgian team is taking responsibility to provide the JEDI collaboration with an essential tool for the EDM measurements at COSY – a high efficient and precision polarimetry system. This is the main project at the SMART | EDM_Lab led by David Mchedlishvili.

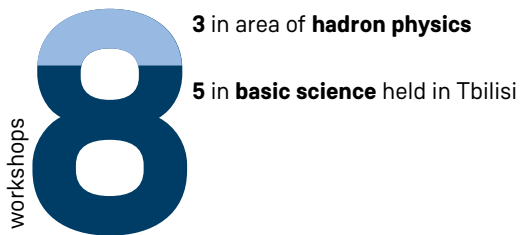
INM-4 projects:

MRIFORLIFE (01DK15018, supported by the German Federal Ministry of Education and Research (BMBF)). Development of novel diffusion magnetic resonance imaging tools for neuroscientific and clinical applications: development of novel MRI methods (FZ Jülich and RWTH Aachen, Germany), construction/engineering of clinical phantoms (GTU, Georgia), clinical testing (FZ Jülich and RWTH Aachen, Germany). This project is designed to largely support young researchers including undergraduate and PhD students. Mutual visits have taken place to support the young researchers aiming at the exchange of experiences and coordinating the work activities for achieving the above aims.

Several Georgian students have won scholarships in the framework of the "Joint Research and Education Programme" of FZJ and Shota Rustaveli National Science Foundation of Georgia. In particular, Mikheil Kelenjeridze performed his Master's thesis in 2017. Ana Gogishvili has started her Master thesis in February 2018. Tamar Khechiashvili, Elene Iordanishvili and Mikheil Kelenjeridze (PhD students) are currently doing their PhD research work related to various topics that are pursued in the INM-4.

Educational Training

Within the framework of our GGSB, we were able to perform:



including: **20** at IKP,
6 INM-4, **1** INM-5, **2** ZEA-1,
2 ZEA-2, **4** IEK-8, **3** JCNS



accomplished and ongoing
includes:
6 IKP, **3** INM-4, **2** IEK-8, **3** JCNS

Knowledge and Technology Transfer

1 PhD thesis de Cotutelle (Zara Bagdasarian)
2 SMART | Labs (SMART | EDM_Lab and SMART | AtmoSim_Lab): Existing SMART | Labs mainly contribute to knowledge transfer; however in future it is foreseen to also substantiate the transfer of technologies.

Equipment provided to Georgian Universities:

1. IKP contribution to TSU (vacuum pump)
2. IKP & INM-4 contributions to GTU (electronics)
3. INM-4 separate contribution to GTU (small MRI scanner for students teaching purposes)
4. IKP contribution to TSU for SMART | EDM_Lab (electronics)
5. IEK-8 contribution to TSU for SMART | AtmoSim_Lab (scientific devices)

Institute directors of Forschungszentrum Jülich namely Prof. Meißner, Prof. Schmidt, Prof. Schult, Prof. Shah, Prof. Ströher and Prof. Wahner have become faculty members of GTU and/or TSU respectively.

Further Activities

Volkswagen Foundation supported educational efforts:

1. Regional Training Network in Theoretical Physics
2. Regional Doctoral Programme in Theoretical and Experimental Particle Physics

DAAD funded 10 senior scientists with 3-months stays in FZJ institutes, namely IKP-2, IKP-4, JCNS, and JSC.

Irakli Keshelashvili submitted an ERC Consolidator Grant on 'Jülich Ballistic Diamond Pellet Target for Storage Ring EDM Measurements' (JuDiT) and David Mchedlishvili submitted an ERC Starting Grant on 'Digital Photon Counting Polarimetry' (DPC-POL).

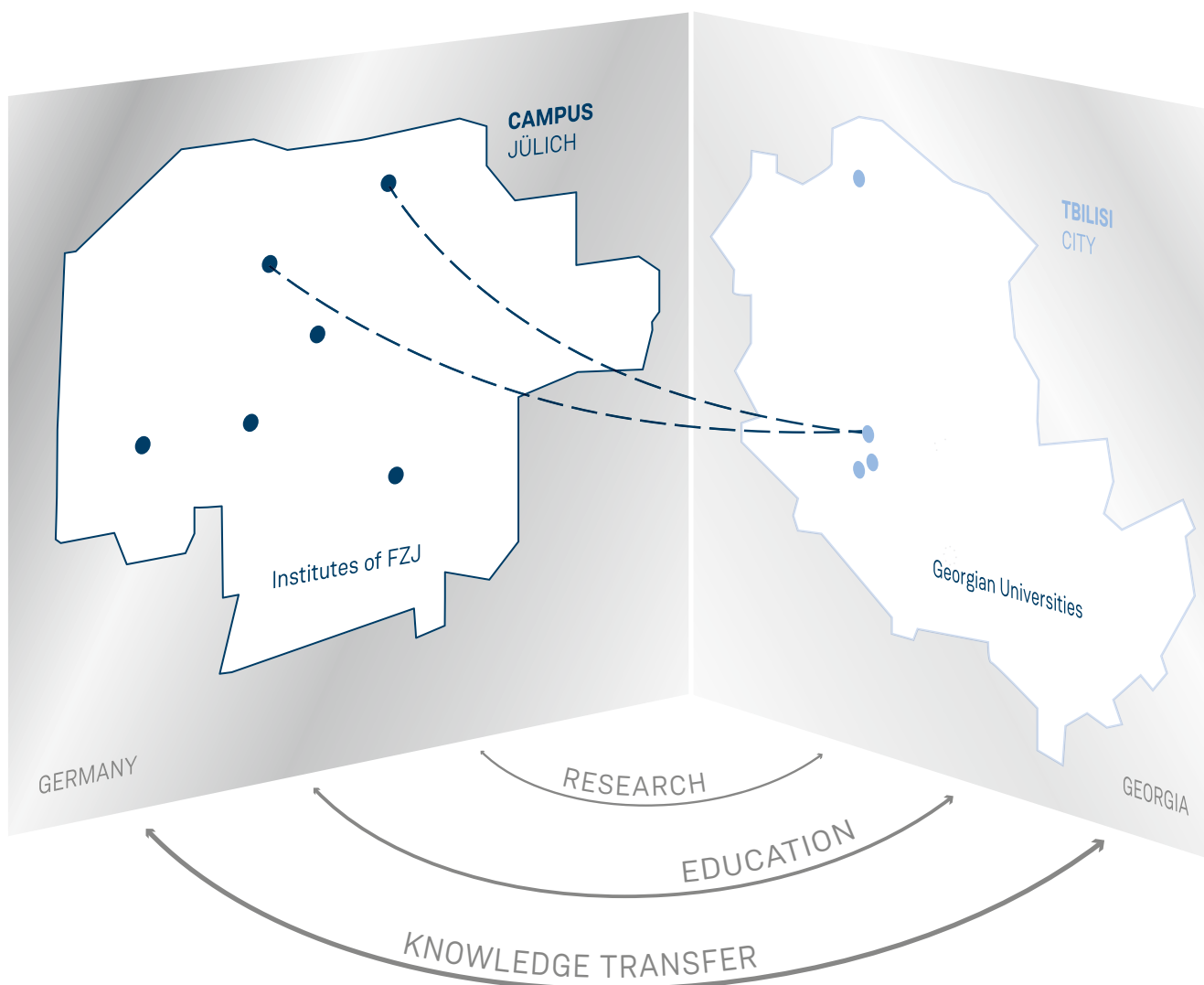
GGSB Vision

The Next Level

Our vision is to coordinate the thematically different labs into a “hub” structure to exploit possible synergies and to mirror the structure of the FZJ in Georgia. We further aim to involve additional partners within Germany and (possibly) Caucasian countries to move the Georgian-German Science Bridge (GGSB) to a Caucasian-German Science Bridge (CSBG). We seek support by German ministries (BMBF, Federal Foreign Office, etc.) and funding agencies (DAAD, DFG, Volkswagen Foundation, etc.) respectively. Furthermore, we would like to support the education of talented Georgian students before

joining the universities by a special training concept. In Germany, we have recognized that it is very important to make talented pupils interested in science during their school years already. Therefore, we have opened a laboratory (JuLab) especially for this purpose at our research centre. Students of all ages can participate in special practical training courses dealing with general scientific questions.

http://www.fz-juelich.de/julab/DE/Leistungen/_node.html



FURTHER SCIENCE BRIDGES

Following the successful example of GGSB, additional science bridges have been initiated by scientists from Jülich to stimulate scientific and technological cooperation with foreign countries.

Australian-Jülich Science Bridge

Forschungszentrum Jülich (FZJ) and the University of Melbourne (UoM) recognise the value of international cooperation and have therefore agreed to intensify their collaboration in several research topics in a structured manner. To achieve this, the partners decided to establish a first German-Australian Science Bridge in 2017 in order to consolidate and expand the existing cooperation in academic and research activities on the basis of mutual benefit.

In order to achieve these goals, the partners are going to initiate joint research projects or implement research collaborations within the Science Bridge. The current scientific focuses include several topics e.g. from the neurosciences, electron

microscopy, the research on terrestrial systems and Bioeconomy, especially plant phenotyping.

The establishment of an exchange programme is intended to systematically expand future cooperation. Starting in 2018, each of the two institutions will provide additional doctoral positions in a first step. Each doctoral candidate will have the opportunity to spend an appropriate period of time at the other institution. In this way, the young scientists contribute to the closer networking of science at both locations and at the same time benefit from the expertise of both institutions. The doctorate should always be completed by awarding two degrees according to the Cotutelle procedure.



MIPT-Jülich Science Bridge (MJSB)

The many years of good contacts between Forschungszentrum Jülich (FZJ) and the Moscow Institute of Physics and Technology (MIPT) necessitates a next step in the collaboration: a Science Bridge between the two organisations with the aim to foster the cooperation further was established in Mai 2016. The joint efforts focus on the areas of Life Science, Soft Matter and Biophysics, solid state and nuclear physics, and on quantum technologies.

It is foreseen that the intensification of the collaboration by this Science Bridge be done by the development of a common roadmap including: the launch of joint institutions, the establishment of a MIPT-Jülich Summer School under a newly structured training programme, regular working group meetings and conferences and by the establishment of an advisory board. The management of Forschungszentrum Jülich is now represented in the international board fo MIPT.



Palestinian-German Science Bridge (PGSB)

The Palestinian-German Science Bridge is a pilot project financed by the German Federal Ministry of Education and Research BMBF and implemented jointly by Forschungszentrum Jülich GmbH and Palestinian Academy for Science and Technology PALAST to develop a joint integrated research and PhD programme.

The Palestinian-German Science Bridge was launched in December 2016. From internships at Forschungszentrum Jülich to BSc, MSc and PhD theses, students have access to state-of-the-art scientific equipment. After successful completion those alumni returning to Palestine after completion of the programme will form the nucleus for the development of sustainable research cooperation and participate in the establishment of research infrastructures including own PhD programmes in Palestine. The programme also includes guest lectures and short term visits at the faculty/staff level.

Until September 2018, 20 cooperation roadmaps have been established involving 12 jointly supervised PhD-, 13 MSc- and 1 BSc-projects.

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As of September 2018

Abbreviations:

ANKE	Apparatus for Studies of Nucleon and Kaon Ejectiles	JCNS-2	Jülich Centre for Neutron Science – Quantum Materials and Collective Phenomena
AtmoSim	Atmospheric Simulation	JEDI	Jülich Electric Dipole moment Investigations
AUG	Agricultural University of Georgia	JuLab	Jülich Pupil Laboratory
BMBF	Federal Ministry of Education and Research	JSC	Jülich Supercomputing Centre
CGSB	Caucasian-German Science Bridge	MES	Ministry of Education, Science, Culture and Sport
CGSWHP	Caucasian-German school and Workshop in Hadron Physics	MIPT	Moscow Institute of Physics and Technology
COSY	Cooler Synchrotron	MJSB	MIPT-Jülich Science Bridge
DAAD	German Academic Exchange Service	PANDA	Polarized ANtiproton experiment at DARMstadt
DFG	German Research Foundation	PAX	Polarized Antiproton EXperiment
EDM	Electric Dipole Moment	PGI	Peter Grünberg Institute
FAIR	Facility for Antiproton and Ion Research	PGI-4	Peter Grünberg Institute – Quantum Materials and Collective Phenomena
FZJ	Forschungszentrum Jülich	PGSB	Palestinian-German Science Bridge
GGSB	Georgian-German Science Bridge	SMART	Science, Medicine, Applied Research and Technology
GGSWBS	Georgian-German School and Workshop in Basic Science	SMART Lab	Science, Medicine, Applied Research and Technology Laboratory
GMP	Good Manufacturing Practice	SMART EDM_Lab	Science, Medicine, Applied Research and Technology Electric Dipole Moment_Laboratory
GTU	Georgian Technical University	SMART AtmoSim_Lab	Science, Medicine, Applied Research and Technology Atmospheric Simulation_Laboratory
HEPI TSU	High-Energy Physics Institute of Tbilisi State University	SRNSF	Shota Rustaveli National Science Foundation
HESR	High Energy Storage Ring	TSU	Tbilisi State University
HGF	Helmholtz Association	ZEA	Central Institute of Engineering, Electronics and Analytics
IBG	Institute of Bio-and Geosciences	ZEA-1	Central Institute of Engineering, Electronics and Analytics – Engineering and Technology
IBG-2	Institute of Bio-and Geosciences – Plant Sciences	ZEA-2	Central Institute of Engineering, Electronics and Analytics – Electronic Systems
IEK	Institute of Energy and Climate	ZEA-3	Central Institute of Engineering, Electronics and Analytics – Analytics
IEK-8	Institute of Energy and Climate – Troposphere		
IKP	Institute for Nuclear Physics		
INM	Institute of Neuroscience and Medicine		
INM-4	Institute of Neuroscience and Medicine – Medical Imaging Physics		
INM-5	Institute of Neuroscience and Medicine – Nuclear Chemistry		
ISU	Ilia State University		
JCNS	Jülich Centre for Neutron Science		

