Researchers for Tomorrow

Research Centre Jülich and its cooperations with universities

Forschungszentrum Jülich
in der Helmholtz-Gemeinschaft

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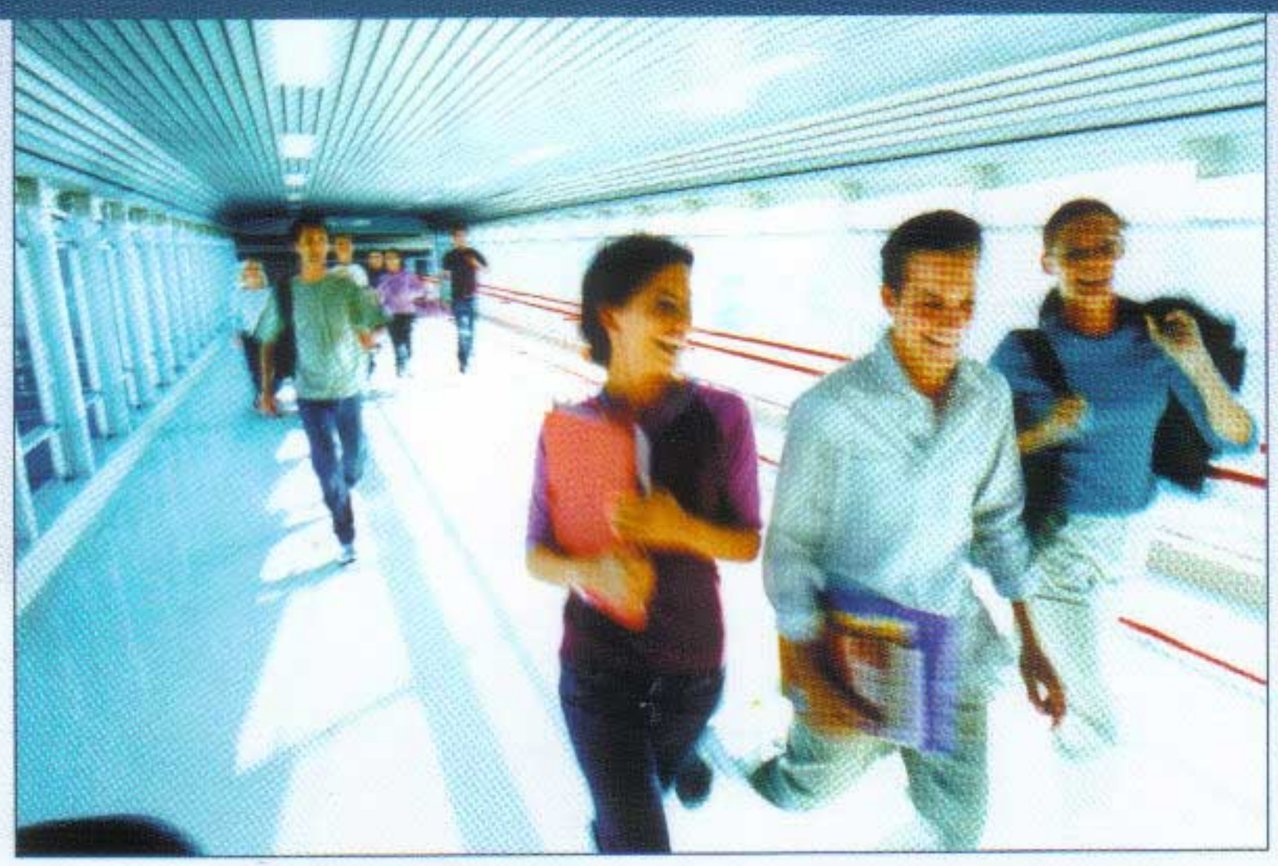

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Curiosity

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Forewords

Hannelore Kraft

For almost 50 years now, Research Centre Jülich has maintained very close ties to the universities in North Rhine-Westphalia (NRW). Such links have involved not only cooperation on organisational and personnel matters but also, and above all, collaboration on a large number of joint scientific projects. This intensive contact has been of benefit to both sides. On the one hand, the universities have access to the Research Centre's exceptional resources; on the other, Research Centre Jülich profits from a steady influx of young scientists and new ideas from the universities. The biggest beneficiary of all, however, is NRW as a location for science and industry. In today's world, a creative research network is not only essential for the solution of complex scientific problems but is also, and above all, a form of economic capital for the future. In this regard, the strong ties between Research Centre Jülich and the universities have played a major role in ensuring that NRW has an outstanding stock of capital for the future. The best-practice examples presented in this brochure are powerful proof of this.

At the same time, it is already clear where the future challenges lie. We need to focus and network research activities in NRW to an even greater extent to ensure that we, with our skills and know-how, play an important role within the Networks of Excellence in the European Research Area. In other words, the tradition that Jülich represents is today more important than ever and I therefore add my express support to all efforts to expand and strengthen these activities.

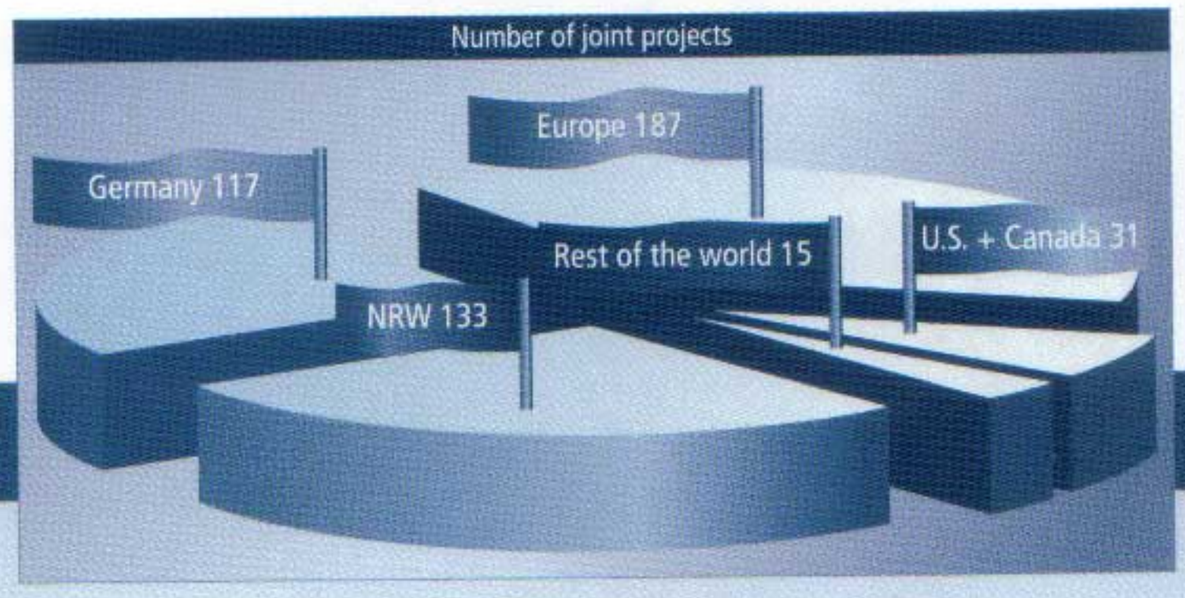
H. Kraft

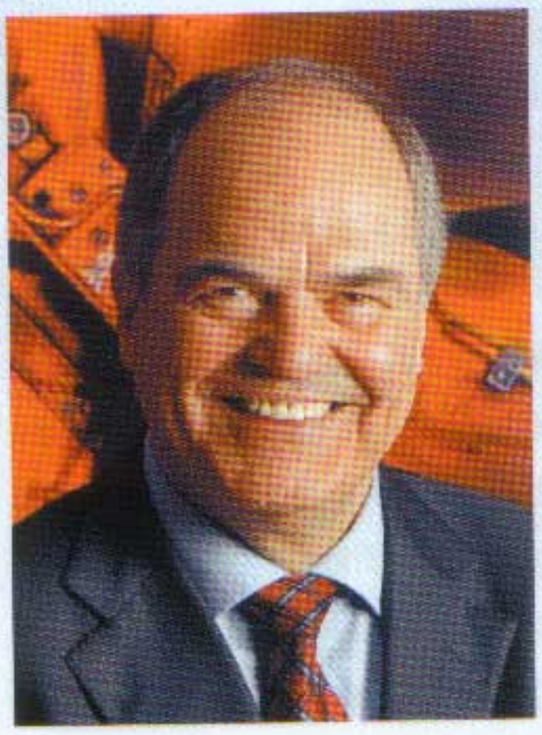
Hannelore Kraft

Minister for Science and Research of the Federal State
of North Rhine-Westphalia

Cooperation between Research Centre Jülich and universities

in projects funded by third parties and on the basis of contracts





Prof. Joachim Treusch

Dorothee Dzwonnek

In recent years, cooperation and a division of labour have become more and more important in science. In the drive to solve the increasingly complex problems of society, we need to overcome the institutional boundaries that once separated basic and applied research. This also means creating closer ties between the work done at universities and research institutions. For this is our only chance to exploit the full potential of science in Germany and thereby take on a major role in the effort to develop a European Research Area that is competitive on the global stage.

From the moment it was founded in 1956, Research Centre Jülich has been paving the way for such a partnership. Participating, as it does, in numerous collaborative research projects with universities, Research Centre Jülich has a long and successful tradition in this area. Indeed, what became known as the "Jülich Model" — joint appointment of professors with universities in the surrounding area — is still a huge success to this very day. At present, 40 scientists from Jülich also have chairs at universities in North Rhine-Westphalia. They, and the many other Jülich scientists also involved in university teaching activities, are helping to educate and train "researchers for tomorrow".

Over the years, we have also developed a worldwide network of close contacts with universities in Europe, the U.S.A., Russia and China. At the same time, we have devised new forms of cooperation, including the establishment of virtual institutes and the creation of temporary research clusters that concentrate on one issue for a limited period.

The examples in this brochure provide an insight into the exciting world of networked research. At the same time, it aims to give a few initial impressions of just what interdisciplinary scientific cooperation can achieve for our future.

Prof. Joachim Treusch

Chairman of the Board of Directors
Research Centre Jülich

Dorothee Dzwonnek

Vice Chairwoman of the Board
of Directors
Research Centre Jülich

From the Jülich

The campus of
Research Centre Jülich

Germany boasts a rich and well-structured research community, including universities, the research centres of the Helmholtz Association, the Leibniz institutes and the research establishments of the Max Planck Society and the Fraunhofer Society. The best way of exploiting such diversity is, on the one hand, to focus similar activities and, on the other, to network researchers with completely different expertise. Outstanding, internationally significant advances in knowledge are most likely to result when the universities, as the core of the science system, work in close cooperation with other research establishments. In this context, Research Centre Jülich looks upon itself as a know-how platform that brings together universities and non-university research in North Rhine-Westphalia (NRW), in Germany, in the European Research Area and beyond.

Research Centre Jülich forms a link between pure research, on the one hand, and industrial development, on the other. For decades now, the hallmark of our research centre has been its intensive cooperation with the universities. Today, such ties are stronger than ever. For example, this is reflected in the numerous joint projects funded by the German Research Foundation (DFG). In NRW alone, Jülich institutes are working with a total of eleven university partners in collaborative research centres.

Over the period from 1999 to 2001, well over 400 non-university research establishments received funding from the DFG. Of that list, Jülich is ranked fifth. Likewise, the large number of patent applications filed by Jülich researchers indicates just how much applied research emerges from the Research Centre's laboratories. Jülich consistently registers around 100 new patent applications each year, a performance that puts it in 143rd position in the world ranking list for international patent applications — way above any other interdisciplinary research establishment in Germany. In bridging the gap between basic research and industrial application, the centre is therefore an ideal partner for the universities.

Opportunities for students and young researchers

Close cooperation between universities and the Research Centre creates a host of special opportunities for young scientists. For example, doctoral and degree students make use of the outstanding facilities at the Jülich institutes and get hands on experience with the kind of large-scale facilities that are rarely available at universities. At the same time, scientists from Jülich are involved in a wide range of teaching activities at the surrounding universities, which means that students profit directly from discoveries at the cutting edge of

Know-how platform

Model to European Networks of Excellence

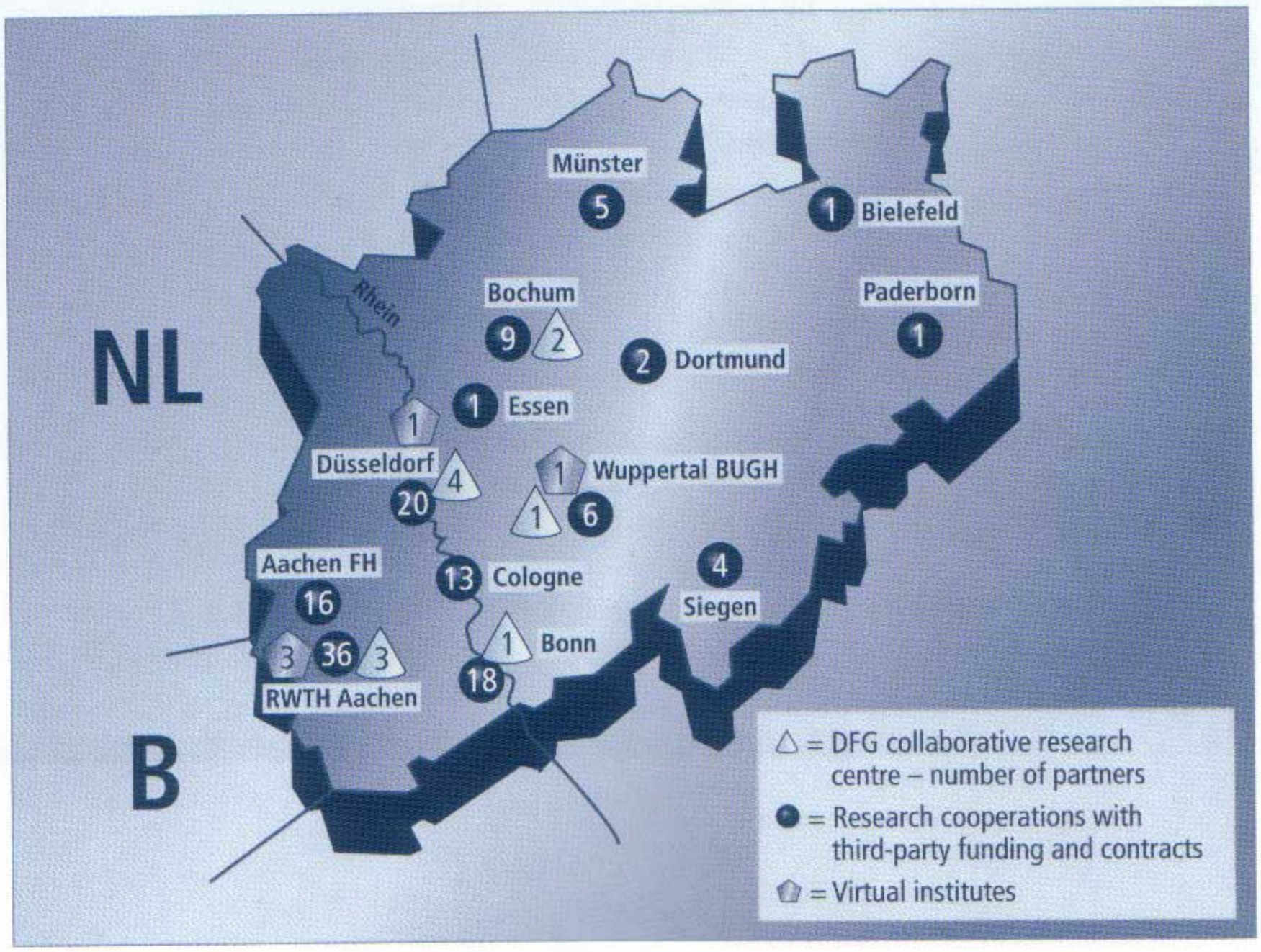
research. For young researchers, too, the Research Centre is an attractive place to begin a career in science. In particular, Jülich is committed to encouraging the promotion of women to senior research posts — by means, for example, of its Tenure Track Programme for young female scientists.

For many years now, the Jülich institutes have maintained close ties to university staff, a prime example here being the so-called Jülich Model, which involves the joint appointment of professors together with universities in the region (cf. p. 25). By the same token, some university researchers are at home on the Jülich campus — those at the Institute of Molecular Enzyme Technology from the University of Düsseldorf, for example, which has been based at the Research Centre Jülich for the past 18 years.

All in all, Jülich scientists cooperate with more than 360 universities.

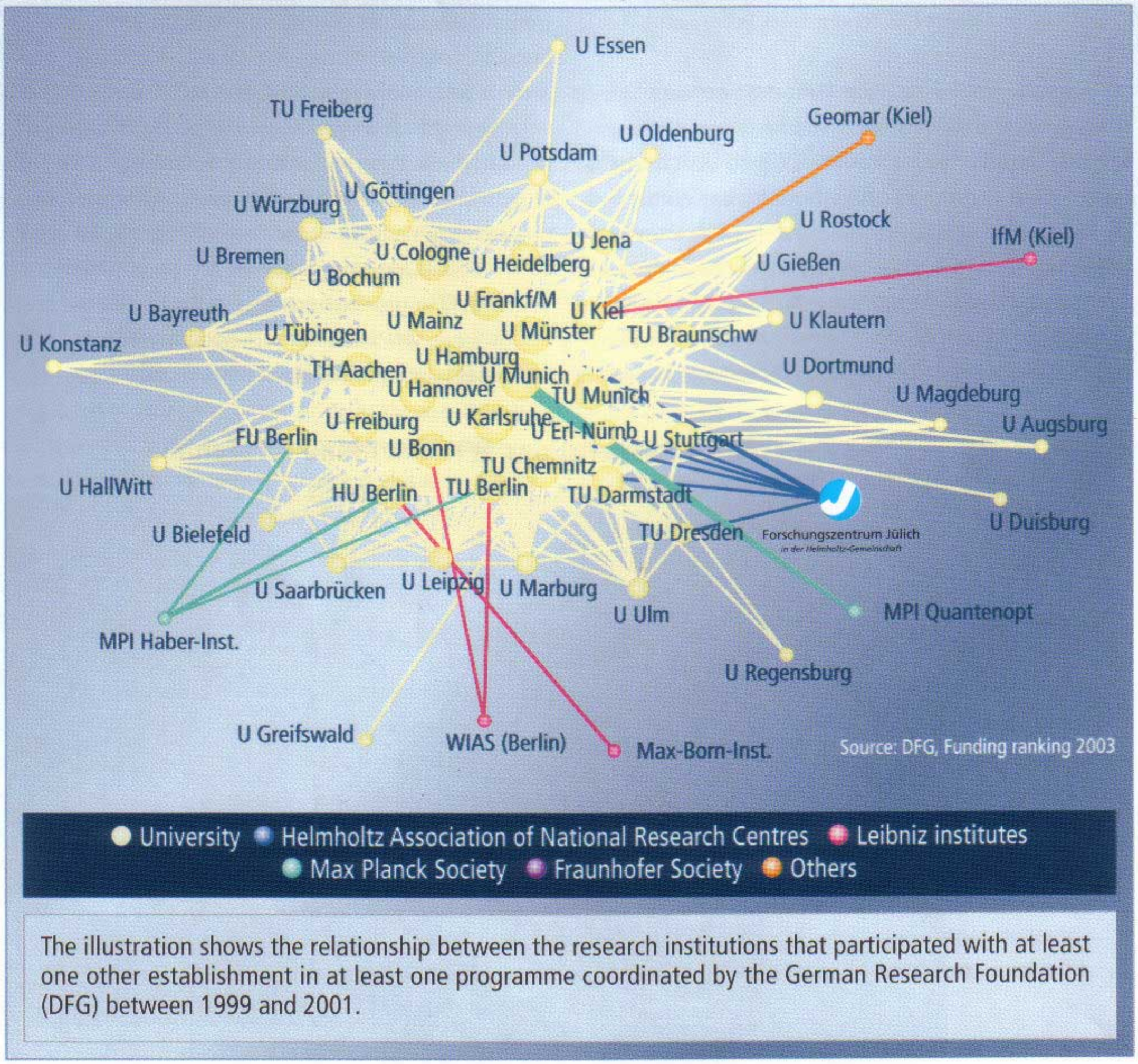
Each year, Research Centre Jülich awards numerous R&D contracts. In 2002, for instance, more than € 2.5 million from Jülich's budget flowed directly to universities at home and abroad. At the same time, cooperation extends beyond the laboratory and the lecture theatre, with representatives from the universities playing a part in research planning and strategic decisions at Jülich. At present, 58 scientists from a total of 37 universities serve on various committees at the Research Centre. All in all, 13 universities are represented on the Scientific and Technical Council, which advises the Board of Directors, the Partner's Meeting and the Supervisory Board on all fundamental scientific and technical issues.

Research cooperations in North Rhine-Westphalia



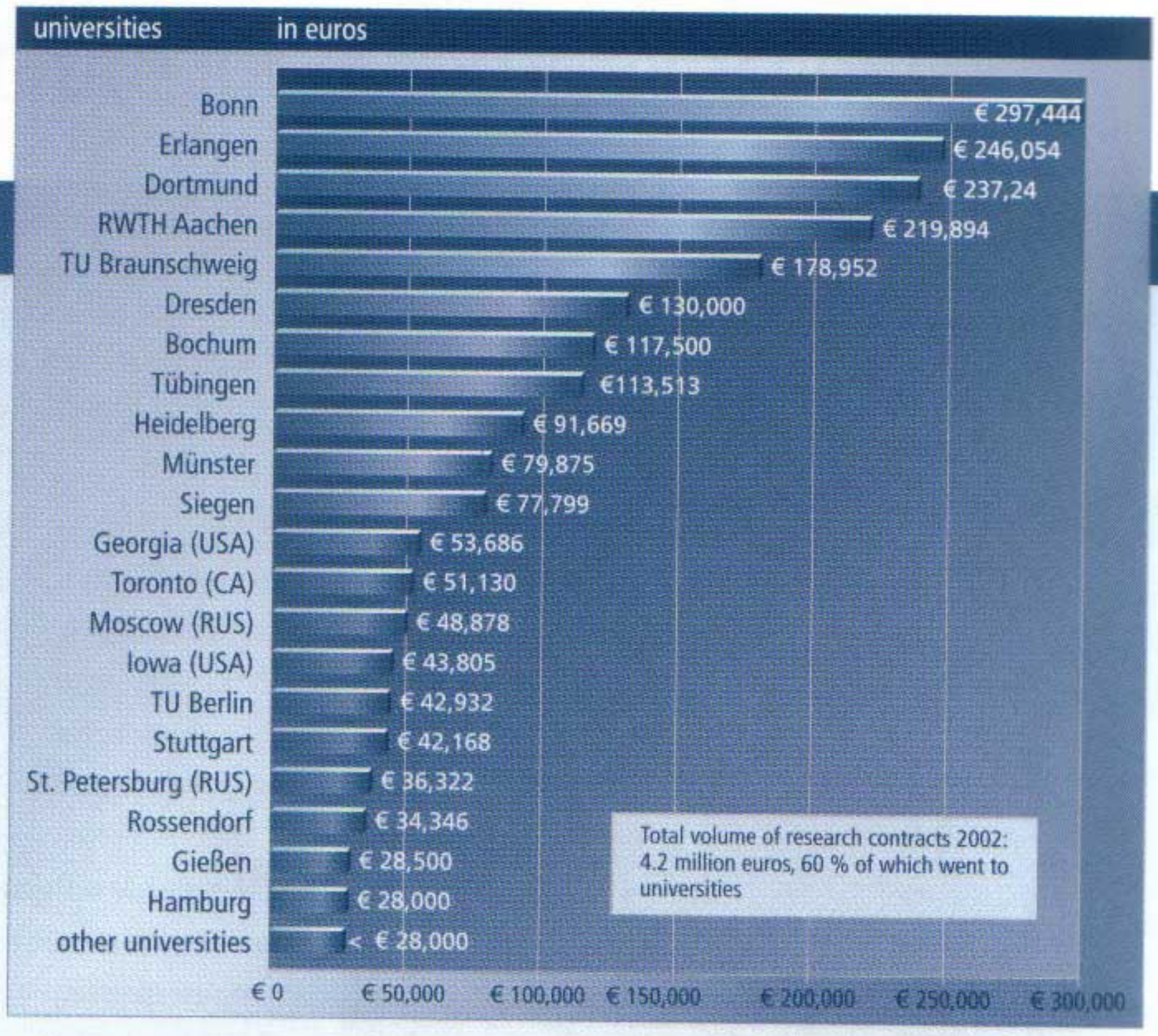
From the Jülich Model to European Networks of Excellence

Network relationship within DFG programmes in the sciences



The illustration shows the relationship between the research institutions that participated with at least one other establishment in at least one programme coordinated by the German Research Foundation (DFG) between 1999 and 2001.

Research contracts awarded to universities by Research Centre Jülich in 2002



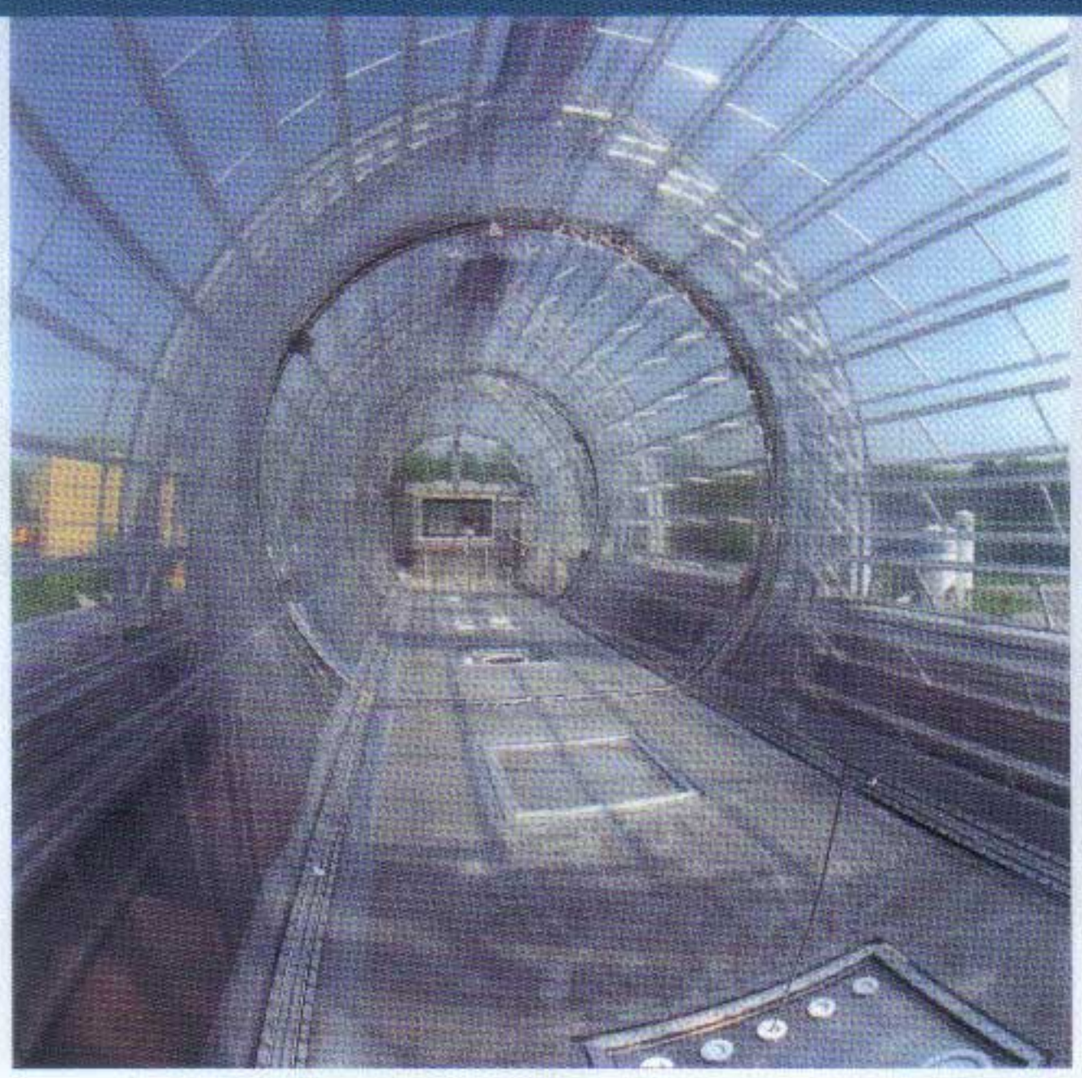
Virtual institutes

Building on its highly successful tradition of scientific cooperation, Research Centre Jülich has now also devised new instruments of collaboration for the future. The aim here is to enter a new dimension of partnership with universities. Financing for this purpose is available from the Momentum and Networking Fund of the Helmholtz Association. An especially intense integration is created through the establishment of so-called virtual institutes. As the name implies, no buildings need to be constructed here. Instead, scientists from different research establishments, but who are working on related projects, network their activities. Thanks to rapid data communications, it is now easier than ever for a group of researchers from distant universities and research establishments to join forces on a common project. Six such virtual institutes were recently set up on the initiative of Research Centre Jülich. The institutes, which have already commenced their work, are in the fields of "Biotic Interactions" (cf. p. 11), "Functional Molecular Systems for Information Technology", "Ice Cloud Formation and Dehydration in the Tropopause Region", "Bioelectronic Hybrid Technology", "Ernst Ruska Centre for Microscopy and Spectroscopy with Electrons" (cf. p. 20) and "Structural Biology".

International research associations

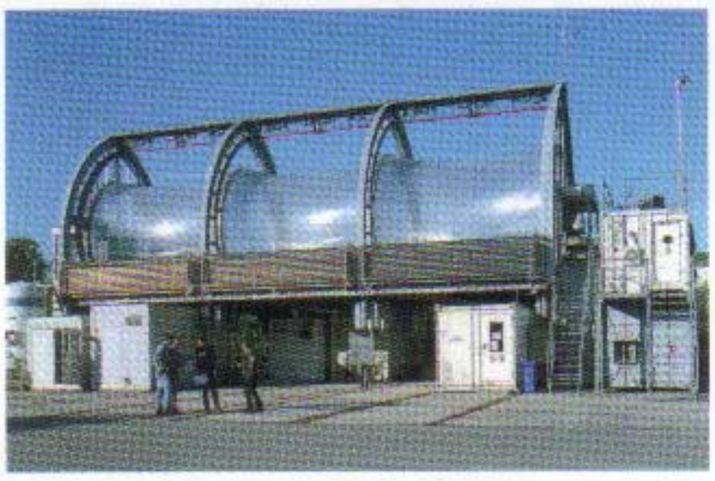
The Sixth Framework Programme of the EU paves the way for a common European policy for science and technology. The concept of the common European Research Area is intended to overcome the fragmentation and parallel developments that still exist in many areas of European science. This is the only way to safeguard the quality and competitiveness of European research in the long term. The EU is therefore giving top priority to the support for large-scale collaborative research — so-called Integrated Projects and Networks of Excellence — which focus the capacity and resources of a large number of strong European partners. This will require not only outstanding researchers but also top-quality professionals with excellent management skills. As one of the largest research establishments in Europe, with many years of experience in managing international projects, Jülich can provide both. ■

Clean Air – The "IDEC" Joint Research Project



The SAPHIR atmosphere simulation chamber is used to simulate air masses of different chemical compositions.

The following pages present examples of successful cooperation between Research Centre Jülich and universities in Germany and also abroad.



Air quality

What's the best way of lowering the level of exhaust gases in the air we breathe? Helping to answer such a complex question is a computer program by the name of EURAD — "European Air Pollution Dispersion model system." EURAD is used to simulate the impact that various measures would have on the concentration of trace gases in the atmosphere, e.g. the ozone content. "The IDEC joint research project was launched to evaluate the results of EURAD and to make its prognoses even more reliable", explains Dr. Hans-Peter Dorn from the Institute of Chemistry and Dynamics of the Geosphere — Troposphere (ICG-II). IDEC stands for "Integrated Data Archive of Atmospheric Chemical Standard Scenarios for the Evaluation of Chemistry Transport Models".

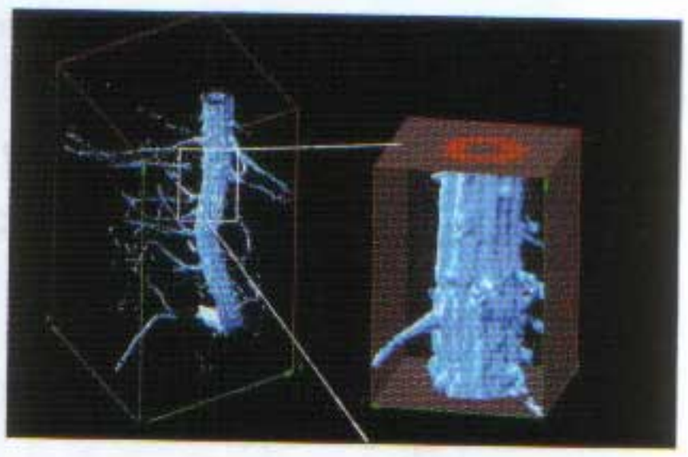
Jülich researchers are collaborating on the project with scientists from the German Meteorological Service (Deutscher Wetterdienst) and the Institute of Geophysics and Meteorology at the University of Cologne, where EURAD was developed. In the large atmosphere simulation chamber, SAPHIR, Jülich researchers mix pure artificial air with selected trace gases and study the resulting chemical reactions. These experimental findings are then compared with the model forecasts calculated by EURAD for the respective conditions. At present, the Jülich researchers are collaborating with both the principle project partners and also with four other universities within the IDEC project. PhD students may, for example, perform research at more than one institution. ■

Plants in Cyberspace – the Virtual Institute for Biotic Interactions

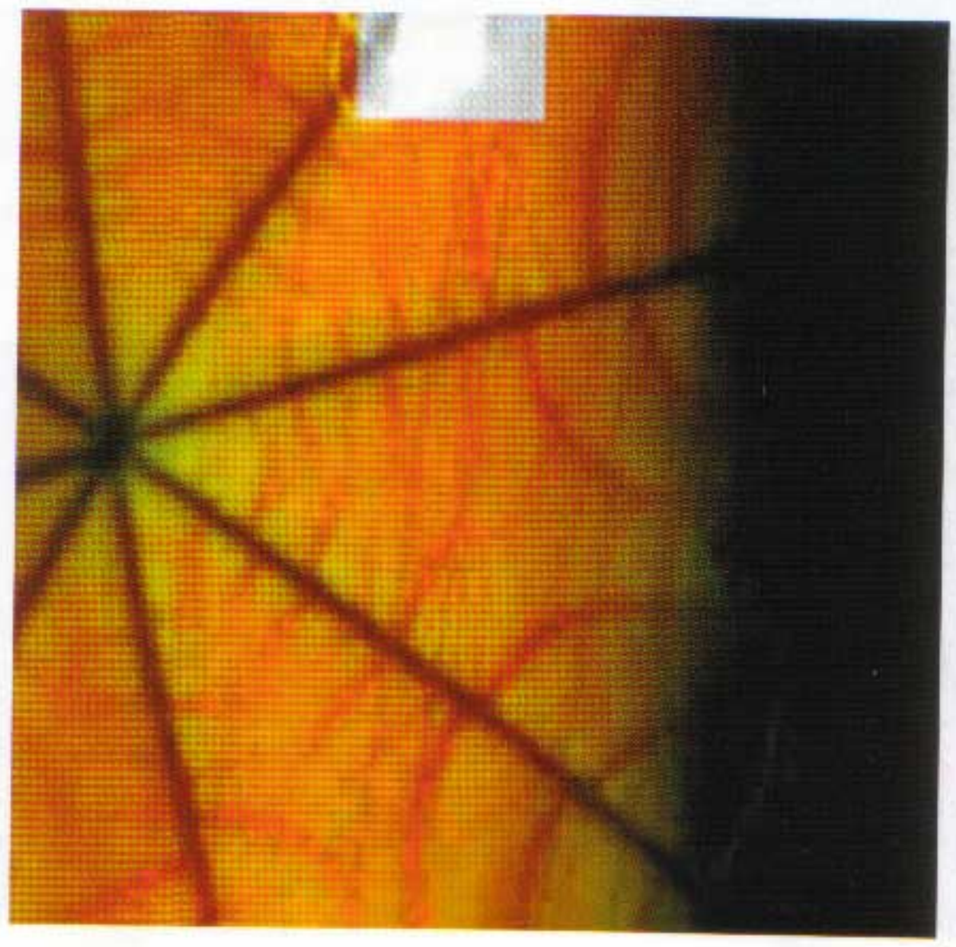
Bio-geo systems

Plants certainly know how to fend for themselves, but may also join forces with other organisms: If afflicted with bacteria or fungi, they can produce signals or defence substances or utilize the defence mechanisms of soil organisms to repel predators. "However, we still have a poor understanding of the interactions between plants and their environment", says Prof. Ulrich Schurr from the Institute of Chemistry and Dynamics of the Geosphere — Phytosphere (ICG-III) at Research Centre Jülich. And yet, it would be of great ecological and economic interest to know about these interactions in greater detail. For example, the study of the interactions between plants, animals and pathogens could help scientists develop "intelligent" methods for plant protection. Such endeavours require extensive interdisciplinary collaboration. Germany certainly has the expertise required, but not all in one place. ICG-III therefore initiated the creation of the Virtual Institute for Biotic Interactions which at present includes partners at GSF in Neuherberg (biochemical plant pathology), TU Darmstadt (animal ecology), and the Max Planck Institute for Chemical Ecology in Jena.

Scientists from these institutes work together closely to study how plants respond to and affect their biotic environment - both in natural ecosystems and in agricultural systems. "Teamwork like this is the only way we can use such an amazingly broad spectrum of methods, ranging from computer-aided image analysis to molecular genetics and artificial microcosms", explains Ulrich Schurr, who acts as spokesman for the virtual institute. "This also exemplifies the structuring role of the Helmholtz Association within the German research community." ■



Plant roots are depicted three-dimensionally by magnetic resonance tomography.

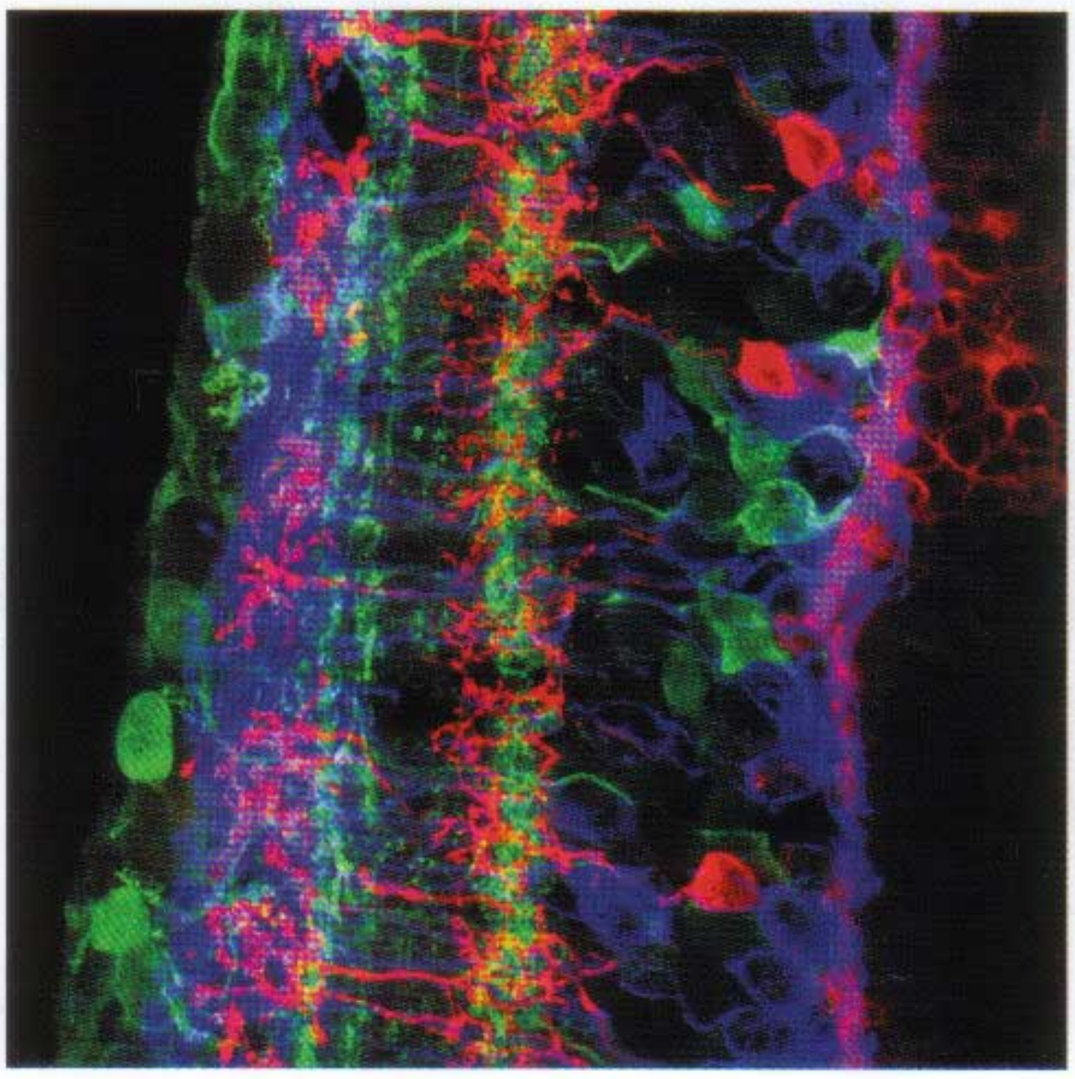


Scientists expose a leaf to different amounts of thermal radiation. Using sequential image analysis, they can then calculate the water content and its distribution in the leaf.

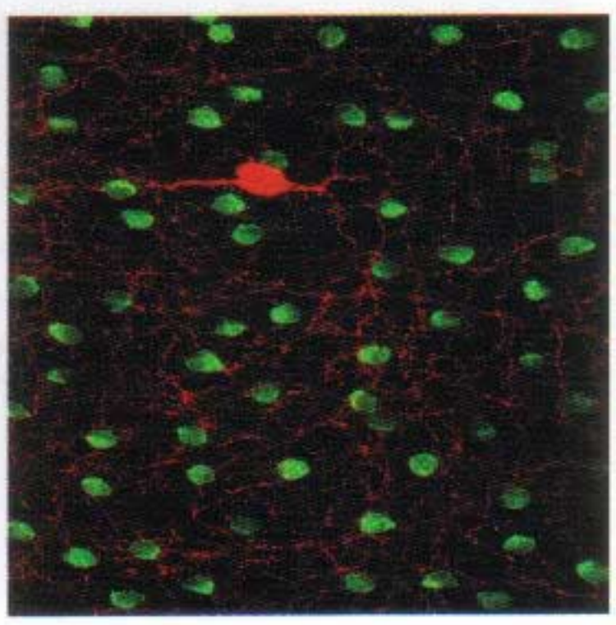
Sensual Biochemistry – The DFG Priority Programme "Molecular Sensory Physiology"

The timer on the oven rings, and a quick glance inside tells us that the cake is perfect. Indeed, it smells so good that our mouths are already watering by the time we take the first delicious bite. During this process, our sense organs have recorded and processed a whole host of information. Sound waves, photons, odour and taste molecules — each type of stimulation is registered by the appropriate sensory cells with the help of special receptors. The result is a cascade of biochemical reactions, which ultimately trigger an electrical nerve signal that is transmitted to the brain. It is the aim of the DFG priority programme "Molecular Sensory Physiology" to investigate such processes on the molecular level. Prof. U. Benjamin Kaupp from the Institute of Biological Information Processing (IBI-1) at Research Centre Jülich is the initiator and spokesman of the programme, which has been running since 1997. His team is involved in several of the 19 projects included in this DFG priority programme. For example, the researchers want to discover why visual cells can even register individual photons, what happens when odour molecules trigger an electric current in olfactory cells, and what is the nature of the molecular "antennae" of gustatory cells. A project in such a complex field as the biochemistry of the senses requires coordinated teamwork among a large number of specialists. Jülich scientists are therefore cooperating closely with colleagues from Universities of Stuttgart, Heidelberg, Tübingen, Göttingen, Mainz, the Humboldt University in Berlin, the Research Institute for Molecular Pharmacology, and the Max Delbrück Centre in Berlin. ■

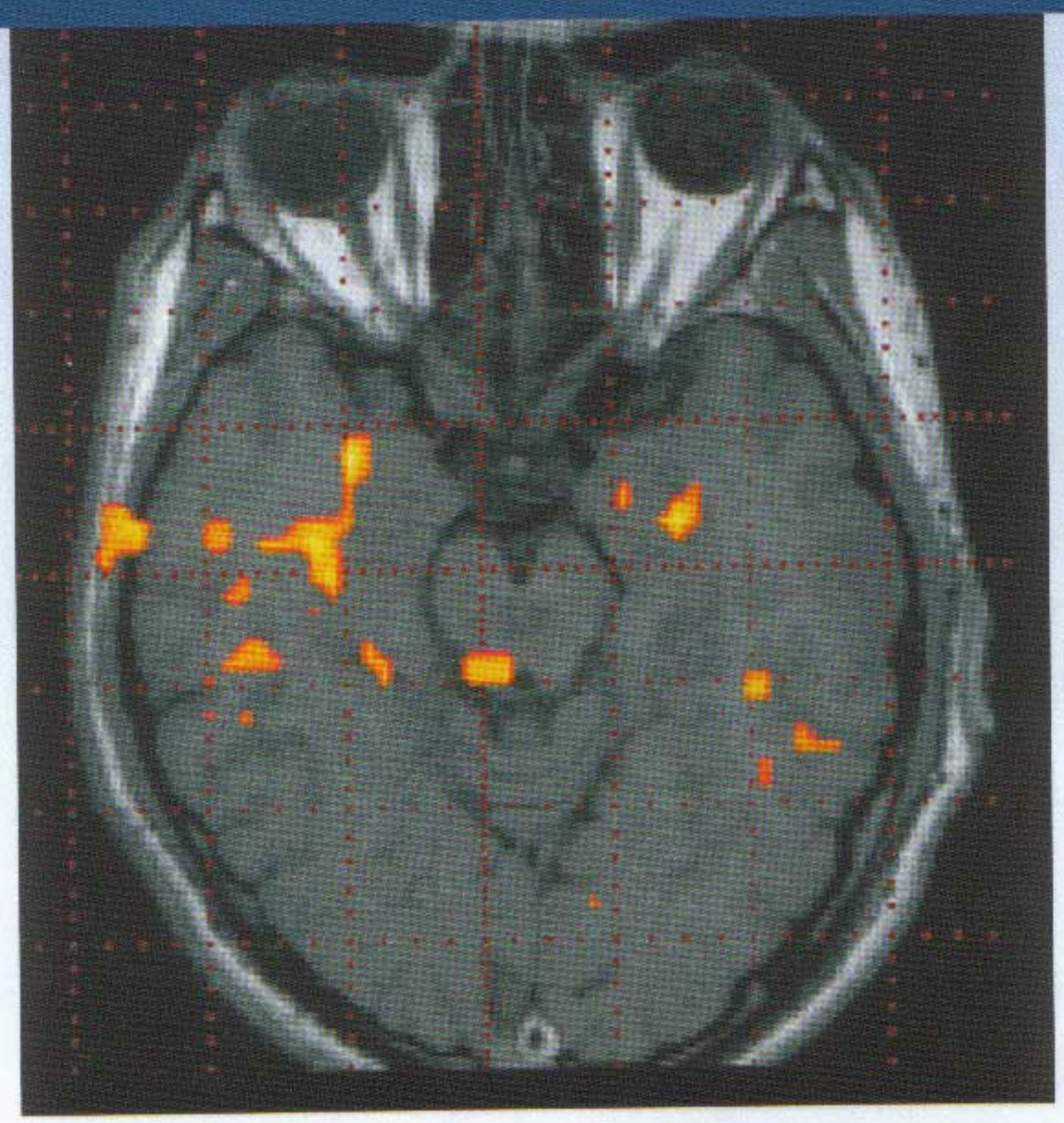
Biochemistry of the sense

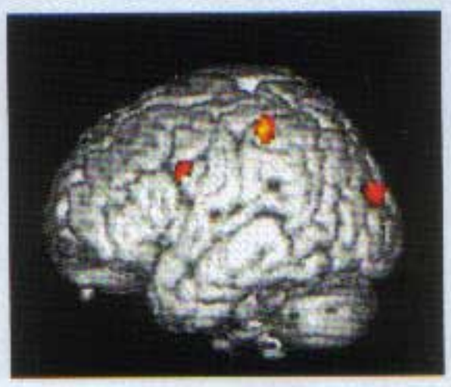


Fluorescent dyes make the various cell types in the retina of a rat visible.



Neurologists' Network – The Brain Imaging Centre West





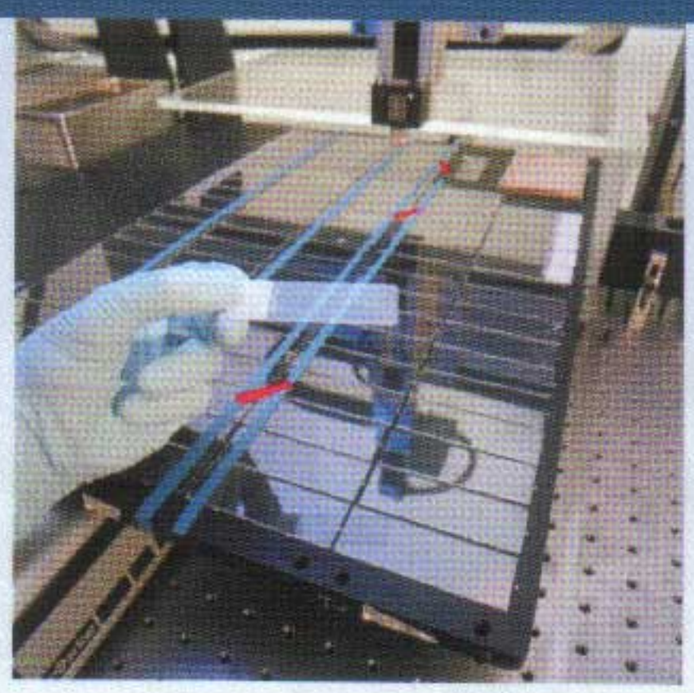
Positron emission tomography (PET) shows which areas of the brain are active while performing different actions.

Why do some children always fidget? How does a stroke impair the functions of the brain? And how can Parkinson's patients be helped? In the Brain Imaging Centre West (BICW) — located at the Institute of Medicine (IME; Director: Prof. Karl Zilles) of Research Centre Jülich — universities and research institutes from North Rhine-Westphalia have focused their efforts to try and answer such questions. The BICW is a network which involves the IME, the Institute of Nuclear Chemistry and the Central Institute for Electronics, both in Jülich, and the Departments of Neurology, Neurosurgery, Psychiatry and Child Psychiatry at the Universities of Aachen, Bonn, Düsseldorf and Cologne. Together, they use brain-imaging techniques to investigate the various disease processes and develop novel therapeutic approaches, including a demand-controlled brain pacemaker.

In its capacity as a "Centre of Excellence for Functional Imaging in the Clinical Neurosciences", the BICW receives funding from the BMBF. Likewise, the DFG also supports a Clinical Research Group at the IME and the University Hospital in Aachen. This interdisciplinary cooperation enables advances in clinically relevant topics that none of the project partners would be able to achieve on their own. The expertise and resources available range from molecular imaging using positron emission tomography to studies of brain structure and function with magnetic resonance tomography, and finally to the development of novel tracer molecules and high-resolution imaging systems. Combined with a vast spectrum of clinical experience, this provides benefits for patients by applying new discoveries. The collaboration is also strengthened by a number of joint professorships (Prof. K. Zilles, Düsseldorf; Prof. Peter Tass, Cologne; Prof. Gereon. Fink, Aachen) as well as exchange and training programmes for junior clinical and scientific personnel. ■

Imaging brain processes

Optimising Management in the Cellular Factory – Genome Research on Bacteria

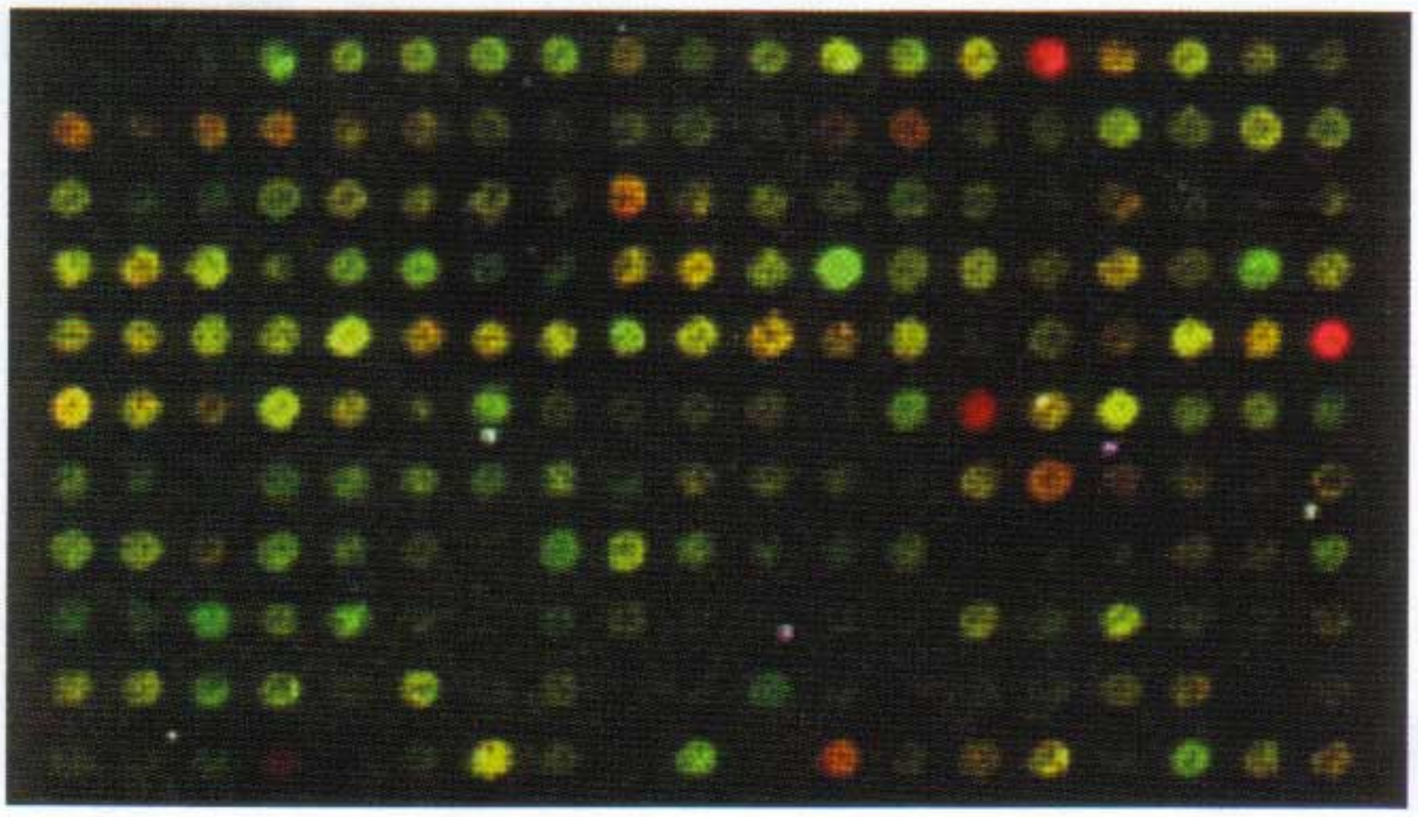


A glass plate carries thousands of DNA fragments.

Beneficial bacteria

There's more to bacteria than just pathogens. Indeed, some of these organisms are incredibly useful, performing such varied tasks as producing amino acids and vitamins, promoting plant growth, and degrading pollutants. Scientists from the Institute of Biotechnology (IBT-1) at Research Centre Jülich are now looking at how such benefits might be enhanced. The broad-based network of excellence "Genome Research on Bacteria for Environmental Protection, Agriculture and Biotechnology" also includes two further research centres, 12 universities and two industrial companies from the federal states of Baden-Württemberg, Berlin, Bremen, Hesse, Lower Saxony, North Rhine-Westphalia, Saxony, Saxony-Anhalt and Thuringia. Prof. Hermann Sahm from IBT-1 heads the group which is investigating the activities of *Corynebacterium glutamicum*. Starting from sugar, a renewable raw material, this microorganism produces various amino acids and vitamins, large amounts of which are required by the feed industry in particular. The Jülich team has developed special DNA chips in order to determine how the bacterial cells control this process and the impact that differences in available nutrients have on this "cellular factory". Such knowledge is essential to help scientists influence the production process. This is the aim of the joint European research project VALPAN — *Corynebacterium glutamicum* as an L-**val**ine or D-**pan**tothenic acid producer — which involves not only Research Centre Jülich but also universities, research centres and industrial partners from six European countries. By intervening in the management of the cells, scientists hope to be able to control the highly versatile bacteria so that they produce specific amino acids or vitamins with high efficiency. ■

The DNA chip shows which genes are active in a bacterium.



An Organisation for Detectives – The Biosensorics Future Workshop

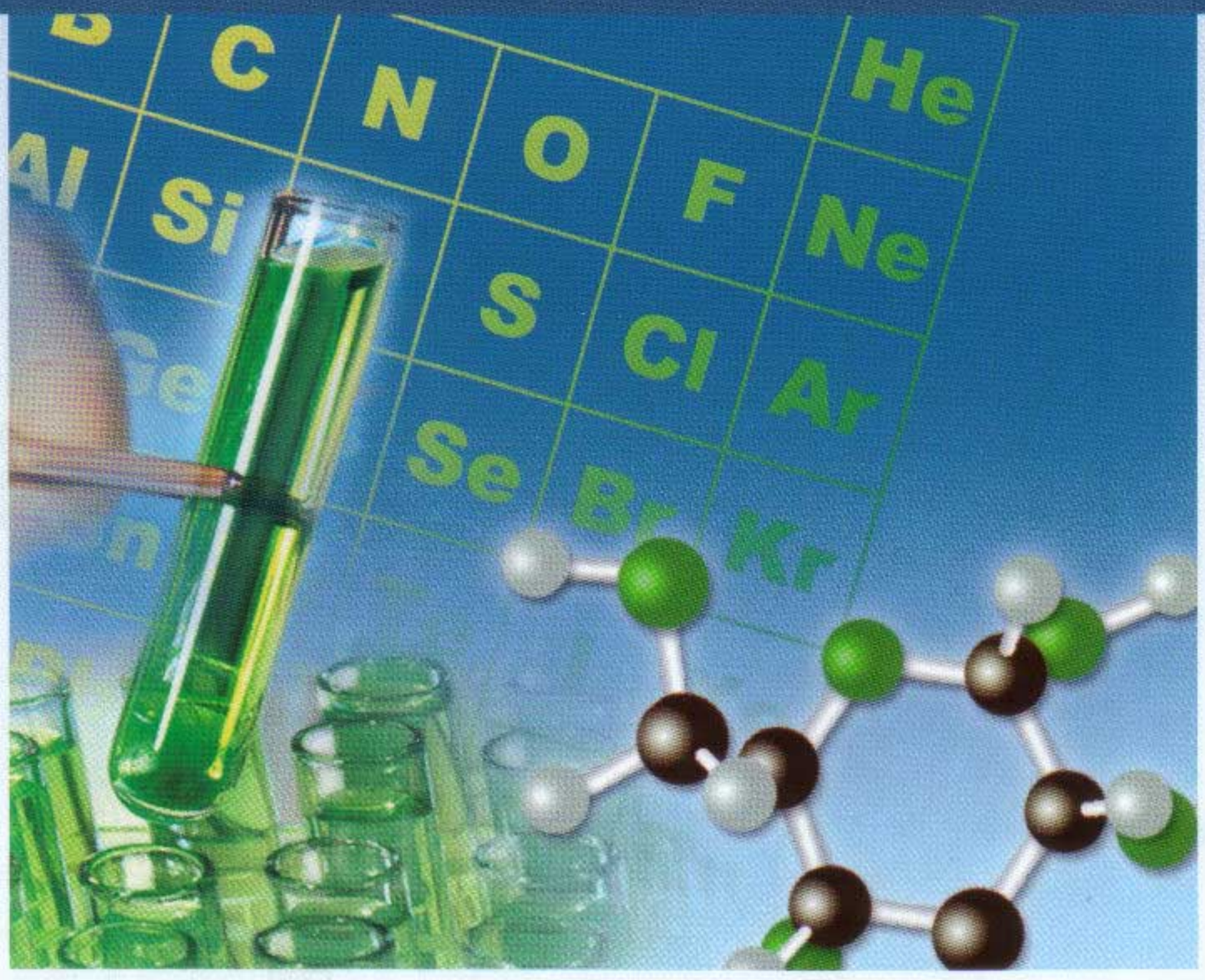
This biosensor is able to track down the valuable constituents of garlic.

Biodetectives

Biosensors take on a number of crucial tasks. For example, they are able to detect the smell of damaged potato plants and so raise the alarm when a potato field has suffered parasitic attack. Similarly, they can identify in garlic the concentration of the specific sulphurous substances which give the plant its medicinal properties. Such biosensors were developed with the help of scientists at Research Centre Jülich. For the past two years, this know-how has also been contributed to the Biosensorics Future Workshop, which is a joint project with Aachen University of Applied Sciences funded by the German Federal Ministry for Education and Research (BMBF) and the state of North Rhine-Westphalia. In order to coordinate and focus research activities relevant to biosensors, the project partners have built up a network involving, to date, about 10 companies and universities.

In addition, the Future Workshop initiates cooperation between science and industry as well as advising the industrial sector on issues relating to sensor technology. Moreover, it also provides schoolchildren with information about a highly promising career area and is involved in basic and advanced training in chemo- and biosensorics. One of the project partners is Prof. Michael Schöning , who introduced a corresponding special subject at Aachen University of Applied Sciences where students are able to experience practical training in a clean-room laboratory provided by Research Centre Jülich. ■

Calculable Reactions – The Collaborative Research Project "HPC-Chem"



It is often not necessary to use a test tube to discover how molecules react – computer programs can predict the results instead.

Catalysts are used to accelerate a whole range of large-scale processes in the chemicals industry. They are a prerequisite for manufacturing many everyday products at an affordable price. Today's chemists search for new catalysts not only in the laboratory but also with the aid of computers: using complex programs they simulate the way in which potential catalysts influence chemical reactions. The aim of the collaborative research project "High Performance Computing in Chemistry" (HPC-Chem), funded by the German Federal Ministry of Education and Research (BMBF), is to enhance the power of such programs and make them at least 10 to 100 times faster. The HPC-Chem project was originally proposed by scientists from the Central Institute for Applied Mathematics (ZAM) at Research Centre Jülich.

It also involves research groups from the Universities of Stuttgart and Karlsruhe as well as the Swiss Center for Scientific Computing, which are the developers of complementary computer programs widely used in industry. "We're pushing forward the development of these programs by improving the methods and algorithms used and, at the same time, adapting them for high-performance computers by the use of parallelism", explains project coordinator Dr. Johannes Grotendorst from ZAM. ■

High-performance computing

Research of the Third Kind at the John von Neumann Institute for Computing

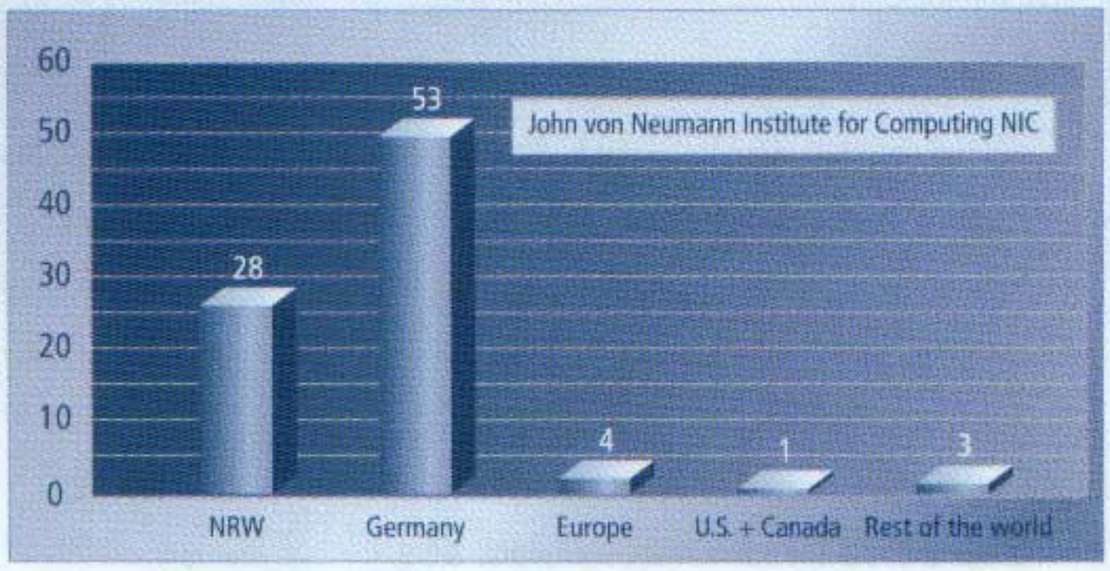
Computer simulation

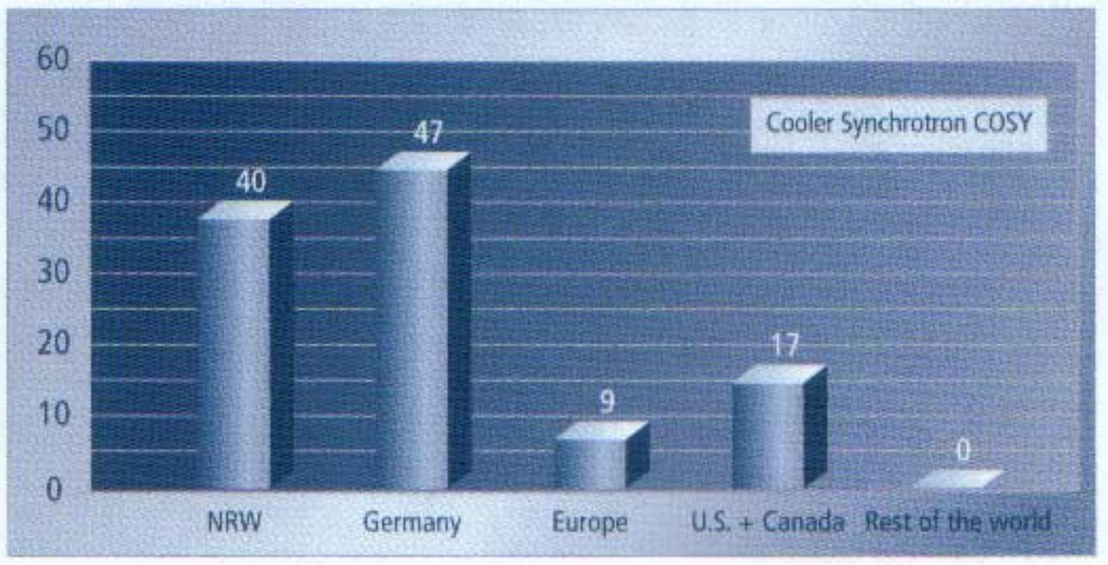
The two traditional pillars of research are theory and experiment. Today, however, they have been joined by a third type of scientific research: computer simulation. This third kind is used in particular by astrophysicists, particle physicists, environmental experts, chemists, engineers, medical researchers and biologists — in short, wherever experiments are too expensive, too dangerous or downright impracticable.

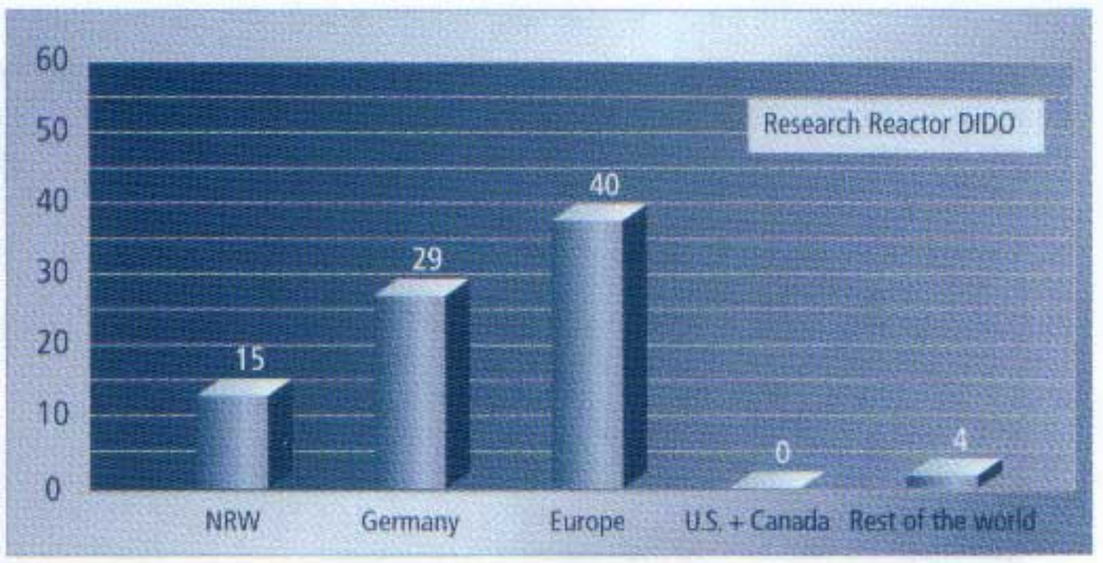
The John von Neumann Institute for Computing (NIC) — a joint facility of Research Centre Jülich and the German Electron Synchrotron Foundation (DESY) — promotes the use of supercomputers in science and provides supercomputing capacity for research projects throughout Germany.

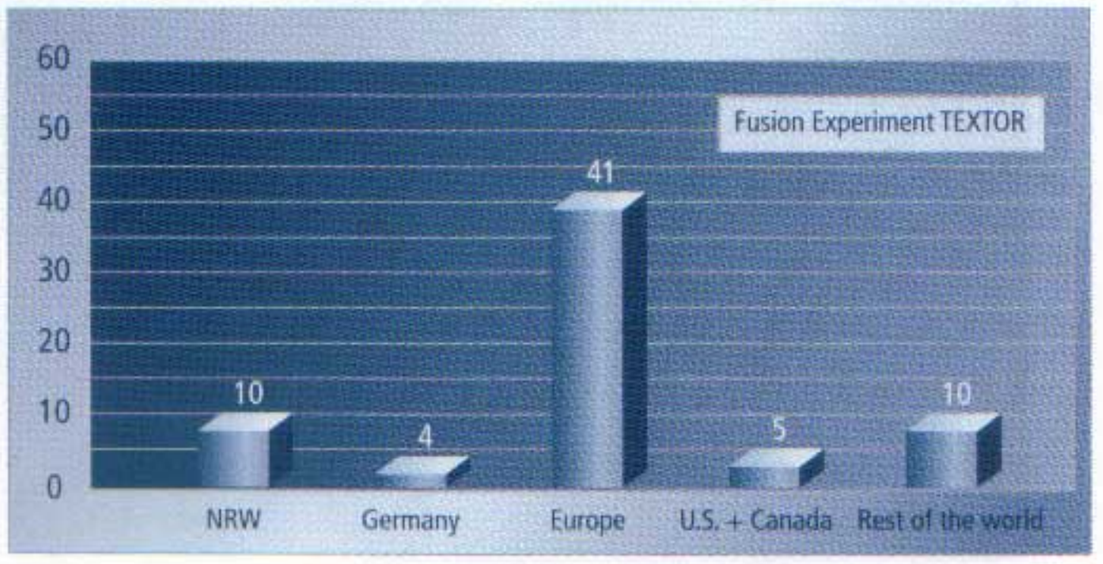
Computer capacity is granted primarily on the basis of independent appraisals in line with the criteria and procedures of the German Research Foundation (DFG). "By far the majority of proposals are submitted by scientists at German universities", says Prof. Richard Wagner, member of the NIC Directorate and the Board of Directors of Research Centre Jülich. For example, 91 out of the 101 projects approved for the period from July 2003 to June 2004 were granted to researchers from universities. NIC enables these scientists to work on problems that are too big to be solved using their university's own computers. ■

Use of large-scale facilities at Research Centre Jülich by universities from Germany and abroad









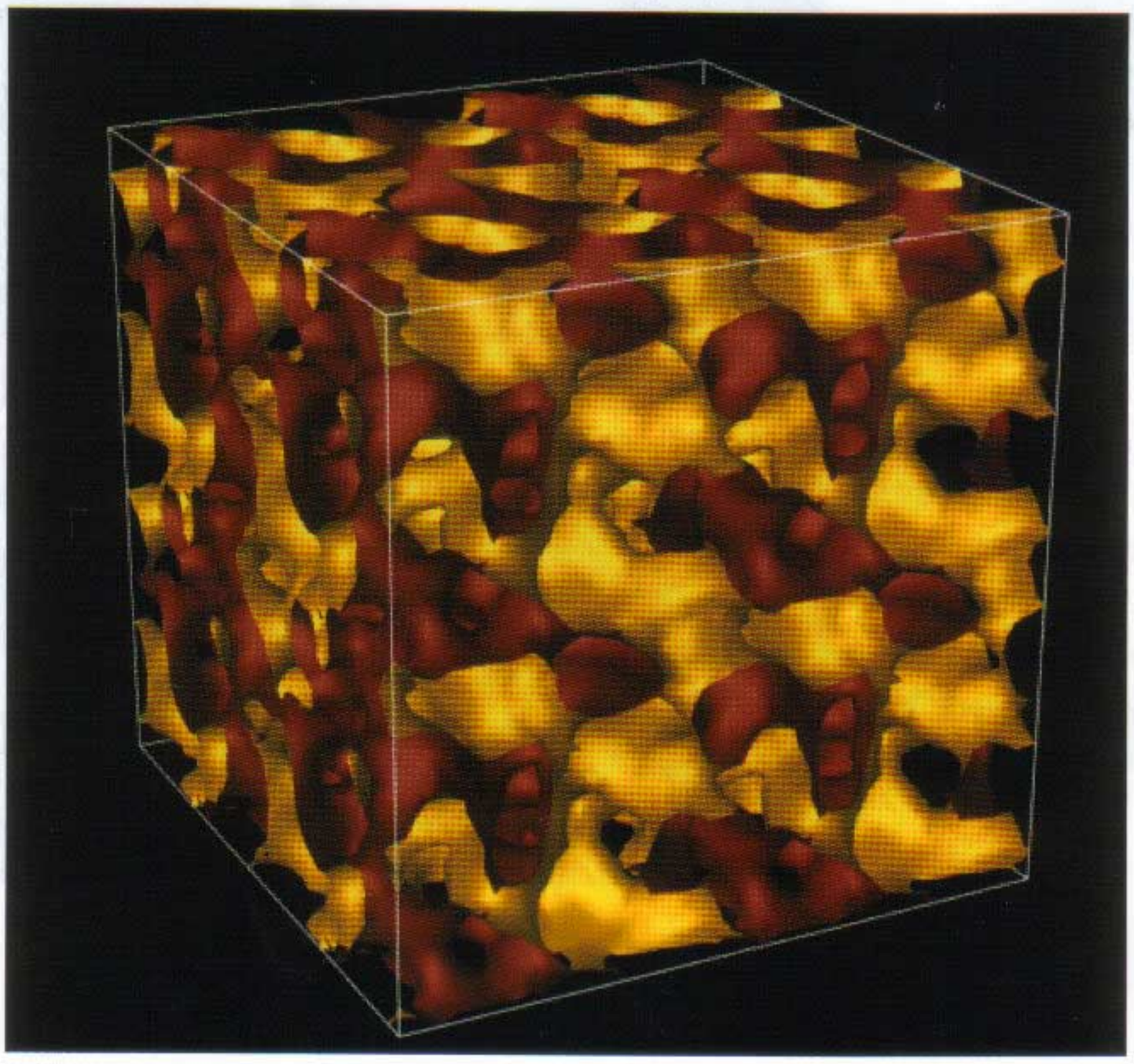
Hard Facts about Soft Matter – The European Network of Excellence "SoftComp"

Soft-matter-composites

What do jelly, washing powder, liquid crystal displays and cling film have in common? They all consist of or contain "soft" matter — as, indeed, does the human body itself. Such substances are neither rigidly structured like steel nor completely disordered like liquids. Instead, they are somewhere in between and often represent highly complex structures — just think of cell membranes.

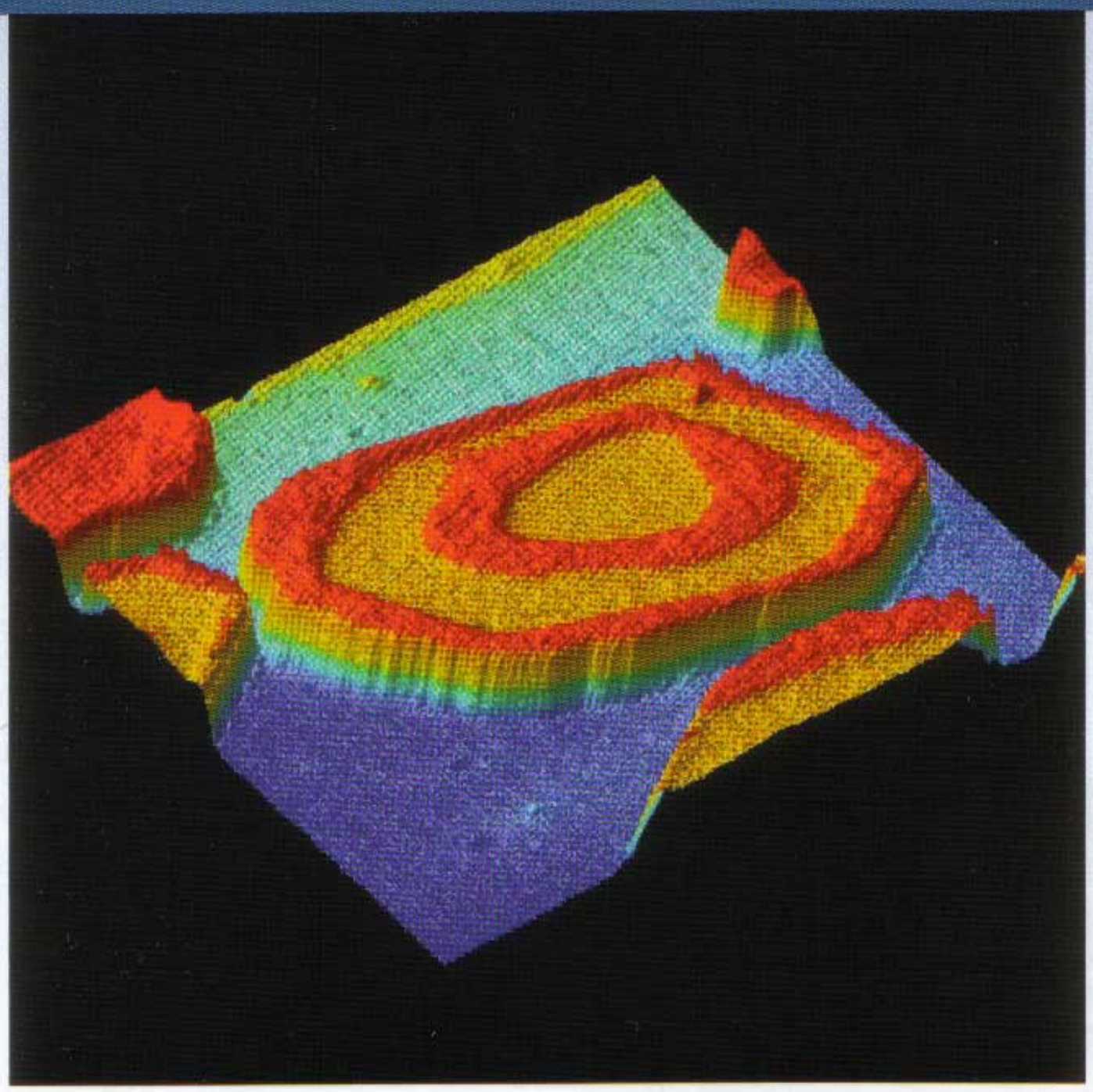
Many of these materials are highly interesting from both an economic and a scientific point of view — for instance, because of their capacity for self-organisation.

The Sixth Framework Programme of the EU supports the creation of so-called Networks of Excellence, which focus the activities of leading research groups in certain fields. Under the leadership of Prof. Dieter Richter from the Institute of Solid State Research (IFF) at Research Centre Jülich, a network by the name of "Soft Matter Composites" — or SoftComp for short — has been established with participation from six research institutes, 15 research groups from universities in seven countries, and seven industrial companies. The aim of the project is to promote research into soft matter and forge a coherent, interdisciplinary network from the many different disciplines and materials represented by the research groups involved. The proposal for the Network of Excellence was considered to be outstanding by the EU assessors and funding was approved in autumn 2003. The resulting network of industrial laboratories, university institutes and research centres brings together experts in physics, chemistry and biology, and creates an ideal platform for investigating the secrets of complex materials and exploiting them for practical applications. ■



The picture shows the internal structure of a detergent microemulsion.

A Journey into the Nanoworld – The Centre of Nanoelectronic Systems for Information Technology

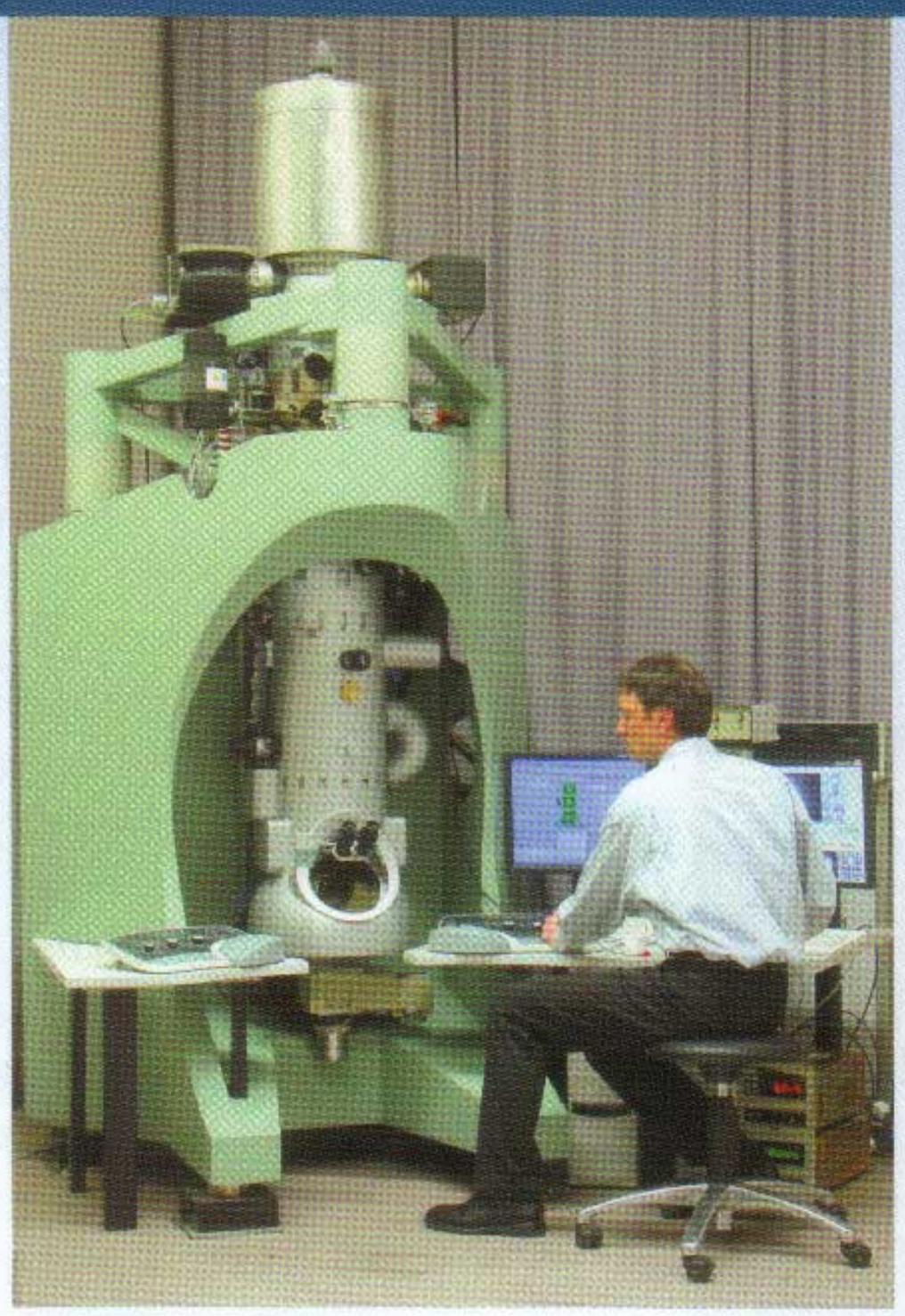


Smaller, faster, better: silicon and germanium rings measuring three nanometres – three billionths of a metre.

Nanoelectronics is a science that may one day bring us a mobile phone that will simultaneously interpret when a Japanese colleague rings, an intelligent car that watches the traffic and intervenes when danger threatens, and a service robot that will do the housework. Before this can happen, however, the logic circuits, memory chips and sensors used in computers will have to become much smaller and more efficient. In turn, this raises many fundamental questions. To answer them, a total of seven institutes from Research Centre Jülich have set up the Centre of Nanoelectronic Systems for Information Technology (CNI). Moreover, in a second step, there are also firm plans to establish a regional research alliance with the NanoClub from RWTH Aachen University. "This research alliance will form a connecting link between the various teams in Aachen and Jülich working on basic research in nanoelectronics", explains Prof. Rainer Waser, coordinating spokesman of the CNI.

The aim of the forthcoming alliance is to initiate and support joint projects such as the existing cooperations in the fields of spin-polarised semiconductors and group III nitrides; to ensure more efficient access to scientific and technical equipment; to plan the joint appointment of professors; and to plan for future large equipment. Moreover, it is intended that this collaboration between CNI Jülich and the NanoClub in Aachen should provide the foundation for further networking on the national and, ultimately, the European level. ■

More Focused than the Nanoworld – The Ernst Ruska Centre



The world's first high-performance electron microscope was developed by the Zeiss subsidiary LEO for the Ernst Ruska Centre in Jülich.

Computer hard discs, packed with huge numbers of bytes, and the microprocessors in PCs, cars and mobile phones are becoming ever smaller, faster and more efficient. More and more functions can be accommodated on a single semiconductor chip. But this development is also creating greater challenges for researchers and engineers, because innovative materials that are manufactured at the nanometre level have to be understood in ever smaller dimensions. In fact, every single atom has to be clearly recognisable. To meet this challenge, researchers now have a powerful high-tech magnification system — the aberration-corrected transmission electron microscope (SATEM). The research team headed by Prof. Knut Urban from the Institute of Solid State Research at Jülich played a major role in the microscope's development. Over the past few years, this new kind of electron optics has led to a worldwide boost in innovation in the electron-optics industry. In turn, extremely high-resolution electron spectroscopy can even be used to analyse the chemical bond between atoms, a method in which researchers from RWTH Aachen University are among the world's leading specialists. The researchers from Aachen and Jülich complement each other in their leading areas of expertise, and this interaction has particularly benefited universities and industrial companies since the beginning of 2004 when Research Centre Jülich and RWTH Aachen University began jointly operating the "Ernst Ruska Centre for Microscopy and Spectroscopy with Electrons" on the Jülich campus. The centre is named after Ernst Ruska, the Nobel prizewinner in physics who invented the electron microscope. "At the Ernst Ruska Centre, researchers can use the world's most powerful electron microscopes equipped with spectrometers," says Urban. "These devices are bringing us close to the limits of what is physically and technically possible." The DFG supports the Ruska Centre extensively. Not only is it represented on the Centre's Supervisory Board, it also finances a major part of the costs of the first new high-performance microscope. In addition, the DFG ensures that researchers who wish to conduct experiments at the Centre have the funds necessary to pay their travel expenses. ■

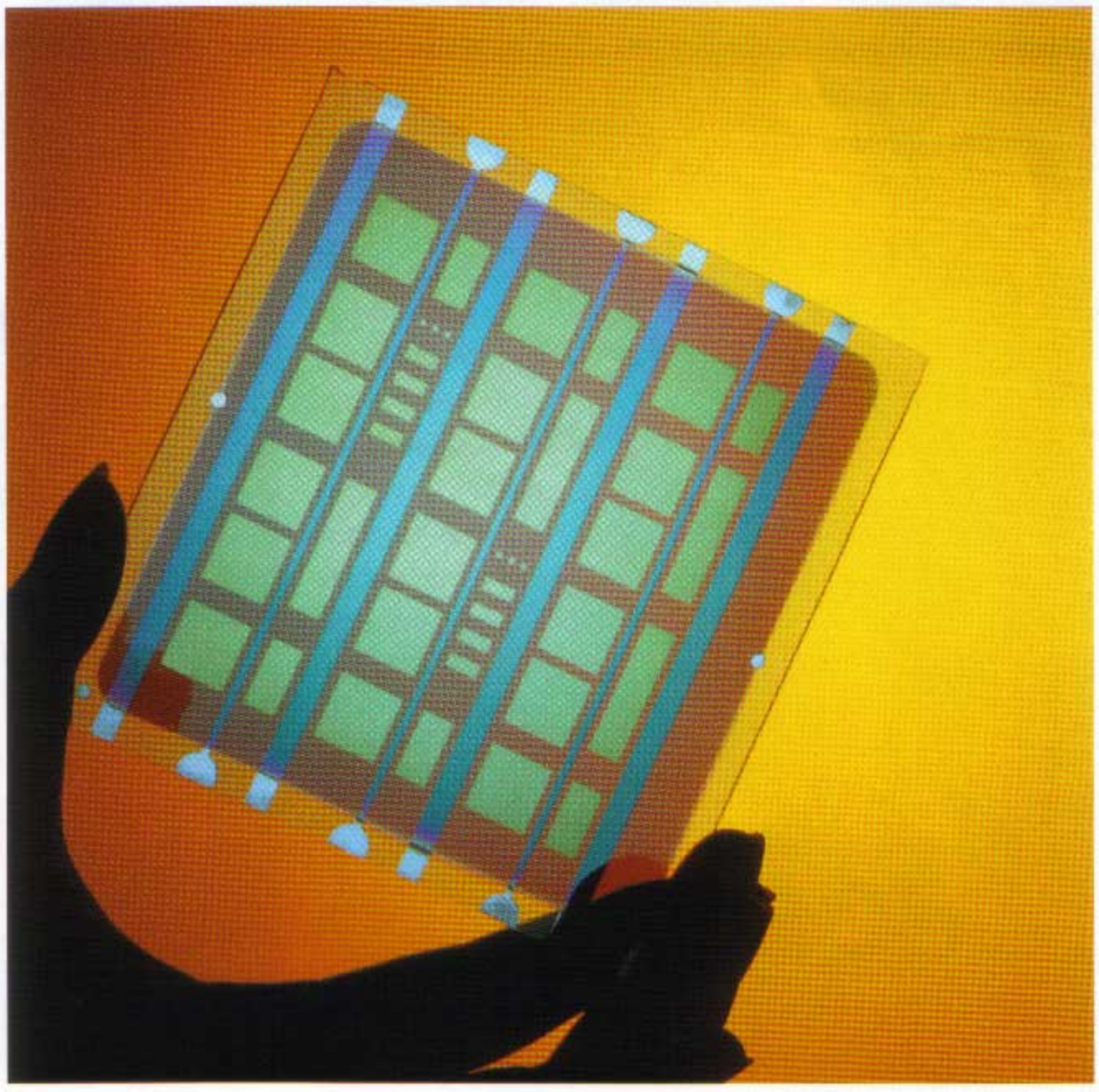
Electron microscope

Sunny Outlook – The Network for "More Efficient Photovoltaic Cells"

Solar energy

Photovoltaic cells convert light into electricity. What's more, they do not release any greenhouse gases in the process. In a collaborative research project, scientists from the Helmholtz Association, the Fraunhofer Society and the Max Planck Society have teamed up with researchers from six universities to try and increase the efficiency of photovoltaic cells — one of the options for making solar energy less expensive.

"By linking all this varied expertise from these research institutions within one research network, we'll be able not only to develop new concepts for photovoltaic cells with higher efficiencies but we will also be able to investigate their potential for practical applications", explains Dr. Reinhard Carius from the Institute of Photovoltaics (IPV) at Research Centre Jülich. Carius is responsible for coordinating the network and is its representative both to fellow scientists and to the general public. The network has two strongly interrelated subprojects to increase the output of photovoltaic cells. The first "photon management" deals with the efficient exploitation of the energy of photons - light particles - for example, in thin film solar cells, by sorting them according to their energy and trapping them within very thin films. The second "band structure design" tackles the problem of the efficient conversion of the photon energy in the semiconducting absorber material, for instance by adjusting its absorption with the help of quantum mechanical effects in stacked ultra-thin layers. ■



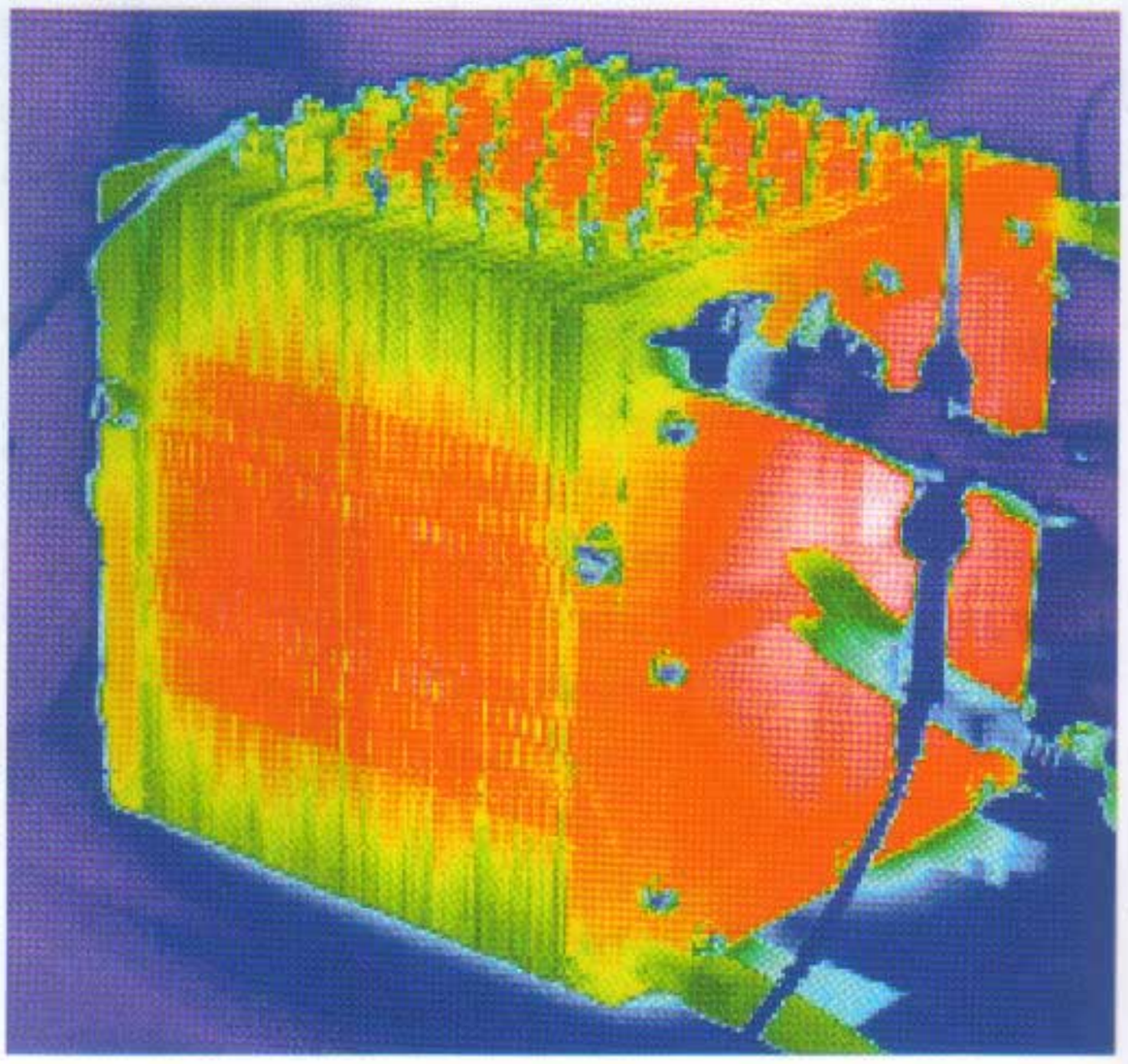
Solar cells convert sunlight into electricity: thin-film photovoltaic cells made of silicon.

Energy for the Future – The Network of Excellence "Fuel Cell NRW" and "Real SOFC"

Fuel cells

Compared to power plants and internal-combustion engines, fuel cells are able to produce more energy from natural gas and other chemical energy sources. What's more, they produce fewer polluting emissions. As such, they are expected to play a significant role in future power generation. The Network of Excellence "Fuel Cell NRW" aims to ensure that North Rhine-Westphalia, as Europe's most important energy region, also plays a leading role in the development and use of fuel cell technology. Scientific Director of the programme is Prof. Detlef Stolten from the Institute for Materials and Processes in Energy Systems — Energy Process Engineering (IWV-3) at Research Centre Jülich. To date, around 230 companies, research establishments and universities have joined the network, which not only initiates projects and helps with the search for cooperation partners and funding programmes but also carries out public relations work, produces information material, and organises workshops and advanced-training events. "The network focuses existing activities in fuel-cell technology as well as generating new expertise", summarises Stolten.

Jülich also plays a leading role in cooperation throughout Europe in studying the solid oxide fuel cell (SOFC). Dr. Robert Steinberger-Wilckens, head of the Fuel Cell Project (PBZ) at the Research Centre, is responsible for coordinating the Integrated Project "Real SOFC". This EU-funded programme involves 26 partners from 11 countries, including five university institutes. The project aims at substantially improving the service life of SOFC systems to a level where they are suitable for practical applications. ■



Fuel cells offer an environmentally friendly way of converting chemical energy – for instance from hydrogen, natural gas or methanol – into electricity.

Let There Be Light – The Project "Environmentally Friendly Gas Discharge Lamps"

As a rule, scientists from the Institute of Plasma Physics (IPP) work with clouds of hot gases — known to the specialists as plasmas — which are many cubic metres in size and are heated to temperatures of millions of degrees. This is because they are principally interested in igniting a solar inferno in the laboratory with a view to developing controlled nuclear fusion reactors and thereby, perhaps, solving the world's energy problems. In the process, the scientists made the amazing discovery that such plasmas have some physical similarities to the much cooler and smaller plasmas found in the gas discharge lamps used, for example, in car headlights or department store lighting.

In what has proved to be an extremely successful partnership, IPP researchers have been cooperating since 1999 with Philips and Osram as well as the Universities of Düsseldorf, Greifswald and Karlsruhe. They have thus been able to improve the spectral properties and durability of gas discharge lamps. In a current project funded by the German Federal Ministry of Education and Research (BMBF), the research partners are now developing lamps that are mercury-free and therefore considerably kinder to the environment. A market launch is expected soon.

The task of the university-based research groups is to use spectroscopic methods to experimentally charakterise the internal properties of the lamps. For the related theoretical calculations sophisticated computer programs are employed at IPP that are otherwise used to design the nuclear-fusion power plants of the future. Which all goes to show that even research focused on the distant future can still produce results that have an application today. ■

Modern lamps are the product of a partnership between Jülich researchers, universities and industry.

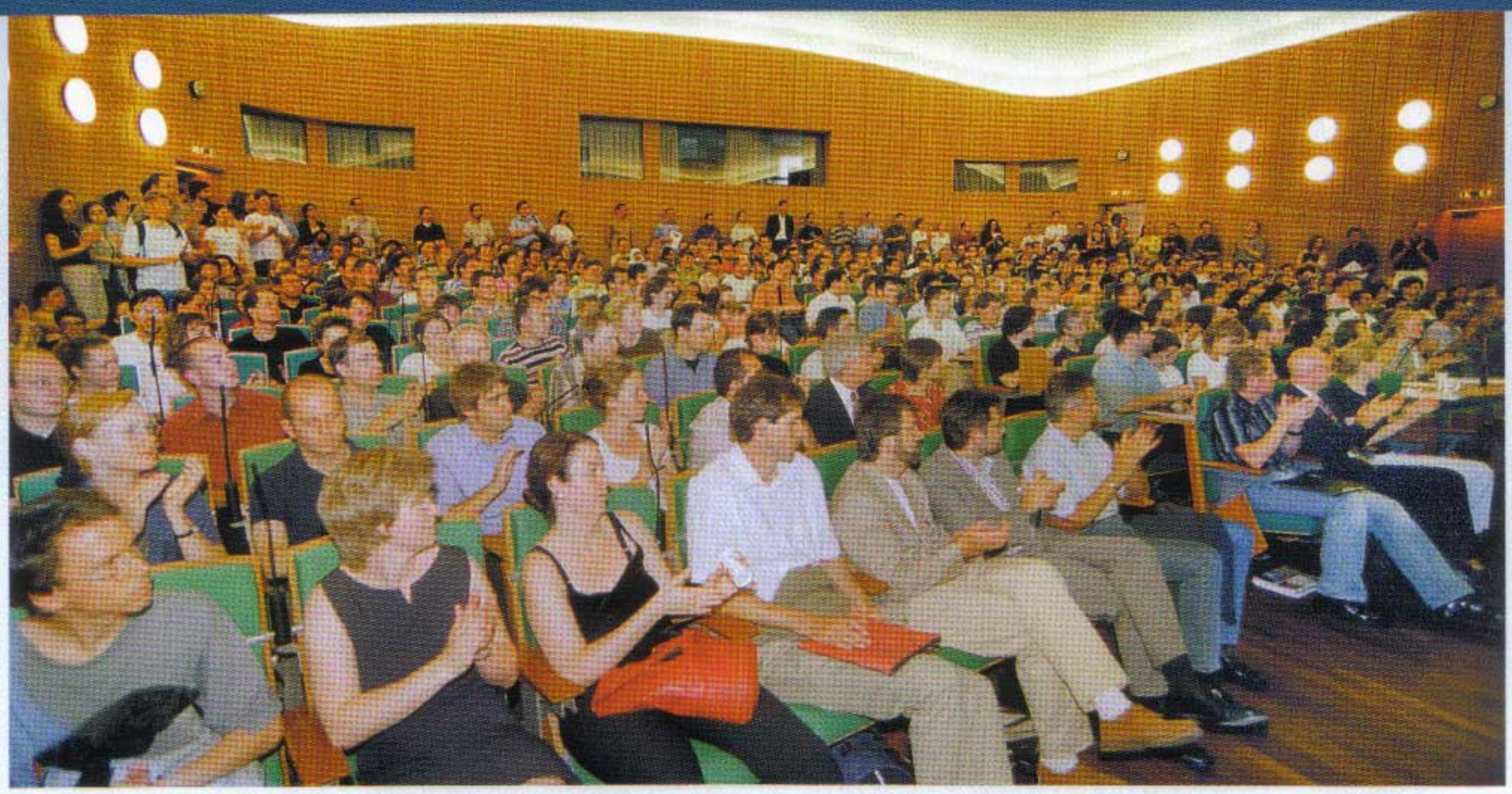
New lamps

A Microscope for Looking into Atoms – The Cooler Synchrotron COSY

"If you want to understand why the world is the way we know it, then you first need to find out why atoms and their constituents are as they are", explains Prof. Hans Ströher, Director at the Nuclear Physics Institute (IKP) of Research Centre Jülich. For such inquiries, the COSY cooler synchrotron serves as a "microscope" studying protons and neutrons, the building blocks of the atomic nucleus. Right from the design stage of the particle accelerator, the Research Centre has always worked closely with the universities in the surrounding area — an alliance that led to the formation of CANU, initially a working group of the universities in North Rhine-Westphalia (NRW) involved in the COSY project. Meanwhile, in the period since COSY commenced operation in 1993, the user community has grown to include universities and research institutes far beyond the state borders of NRW. Today CANU et al. includes scientists from the Universities of Bonn, Bochum, Dresden, Erlangen, Gießen, Cologne, Hamburg and Tübingen, and Research Centre Rossendorf as well as from the University of Cracow and the Andrzej Soltan Institute for Nuclear Studies in Swierk (Poland), Moscow State University, the Joint Institute for Nuclear Research (JINR) in Dubna, the Petersburg Nuclear Physics Institute (PNPI) in Gatchina, and the Institute for Theoretical and Experimental Physics (ITEP) in Moscow (Russia) and also Michigan State University (U.S.A.). Each year, a few 100 scientists come to Jülich to perform experiments at COSY, since it constitutes a unique facility worldwide for science and universities both in Germany and abroad. At the same time, given the many different scientific and technical requirements made on COSY, Jülich's extensive experience in the management of large-scale equipment is a great bonus. The long list of joint publications testifies to the success of this alliance, as do events such as the conference "Physics at COSY 2003" and the COSY Summer School, which last year attracted researchers from 11 countries. ■

Protons race around the 184-metre COSY track at almost the speed of light. Their subsequent collision with a target yields information about the reaction and thus provides valuable insights into the building blocks of the atomic nucleus.

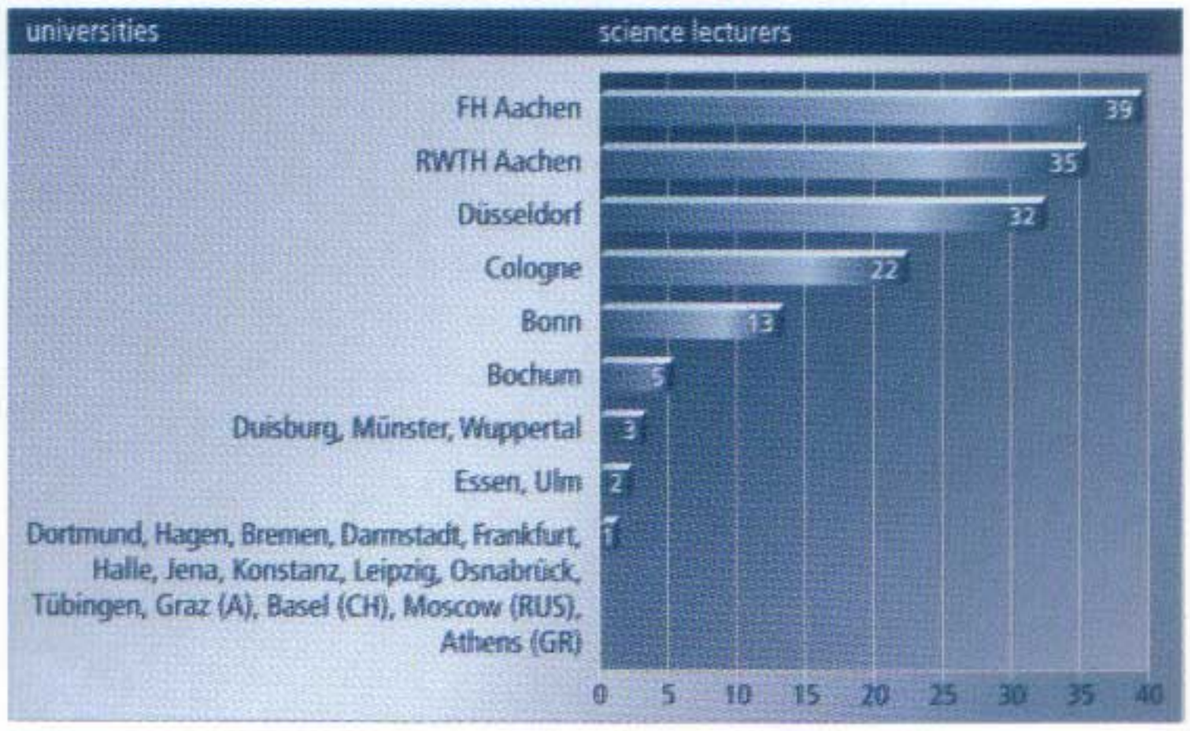
Training the New Generation



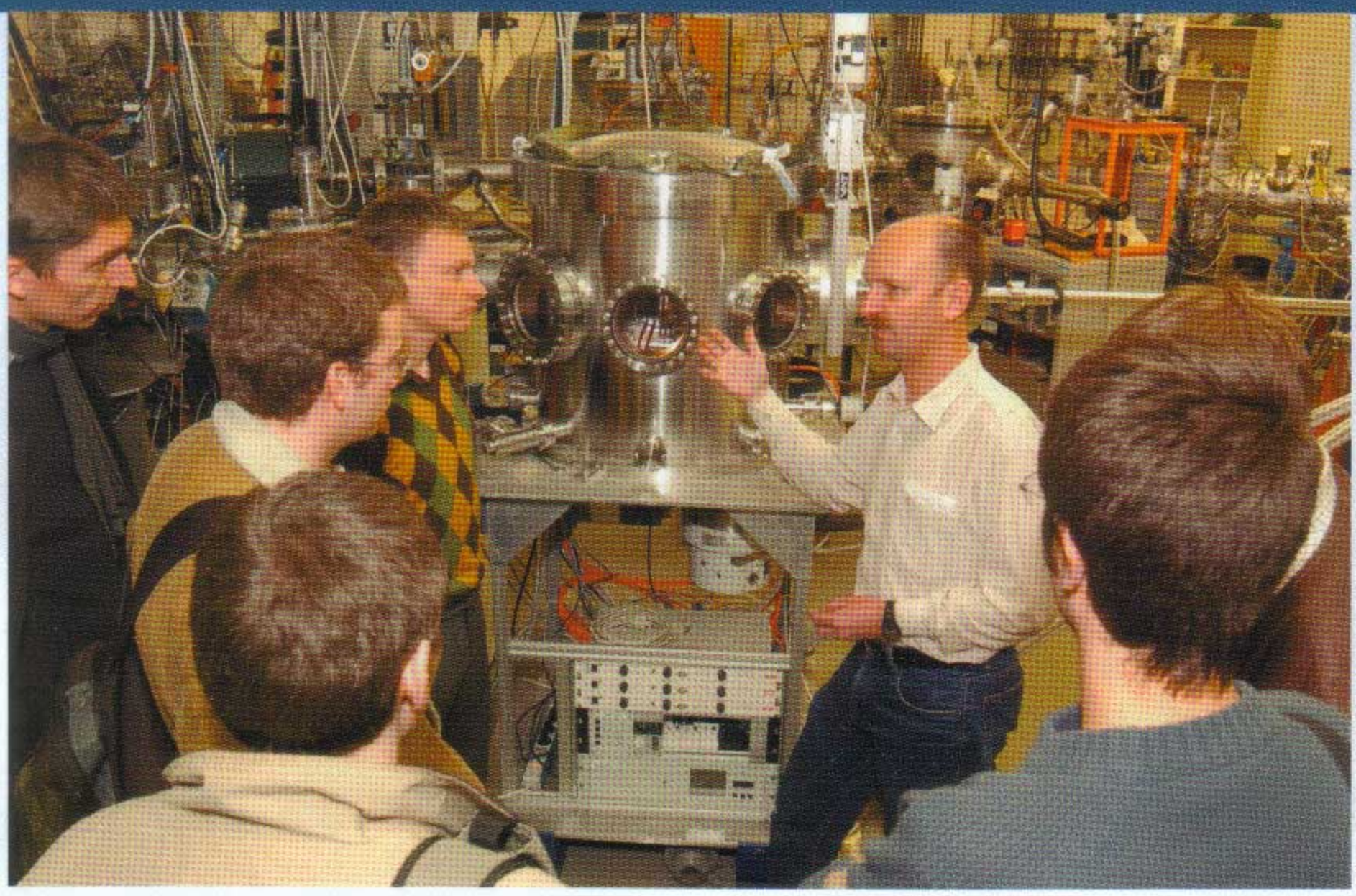
Today's students are tomorrow's inventors and problem-solvers. If our society is to be able to develop new materials and technologies, and to solve such pressing issues as future energy production and protection of the environment, we need to have many talented and committed young people studying scientific and technical subjects. Research Centre Jülich therefore works hand in hand with universities to ensure that science students receive an excellent education.

Some 500 young scientists attended a meeting at Research Centre Jülich in 2003 to find out about funding opportunities for their research. The event was staged jointly with the Universities of Aachen, Bonn, Düsseldorf, Cologne and Maastricht, the EU liaison office of research organisations, and the NRW Ministry of Science.

Teaching activities of scientists from Research Centre Jülich at universities (as of: 2003)



Training the New Generation



From the lecture theatre to the lab: hands-on experience for young researchers at the Institute of Solid State Research in Jülich, where an annual two-week spring school has been held for the last 35 years.

Many of the scientists in Jülich have a twofold function: they head one of the institutes at the Research Centre and also hold a chair at one of the universities nearby. This was a complete novelty in the 1960s, but what became known as the Jülich Model has proved invaluable up to the present day.

The Jülich Model paves the way

Today, many other German research establishments have followed the example of the Jülich Model, which forges such strong links between science and teaching, universities and the Research Centre. At present, 40 Jülich scientists also hold a professorial chair, and many others are involved in teaching. All in all, one in five scientists at the Research Centre (excluding doctoral students) teaches at one of 29 universities. But the Research Centre Jülich doesn't just reach out to the universities, it also invites students to come and broaden their horizons by experiencing the atmosphere at one of Germany's largest research establishments.

Summer schools

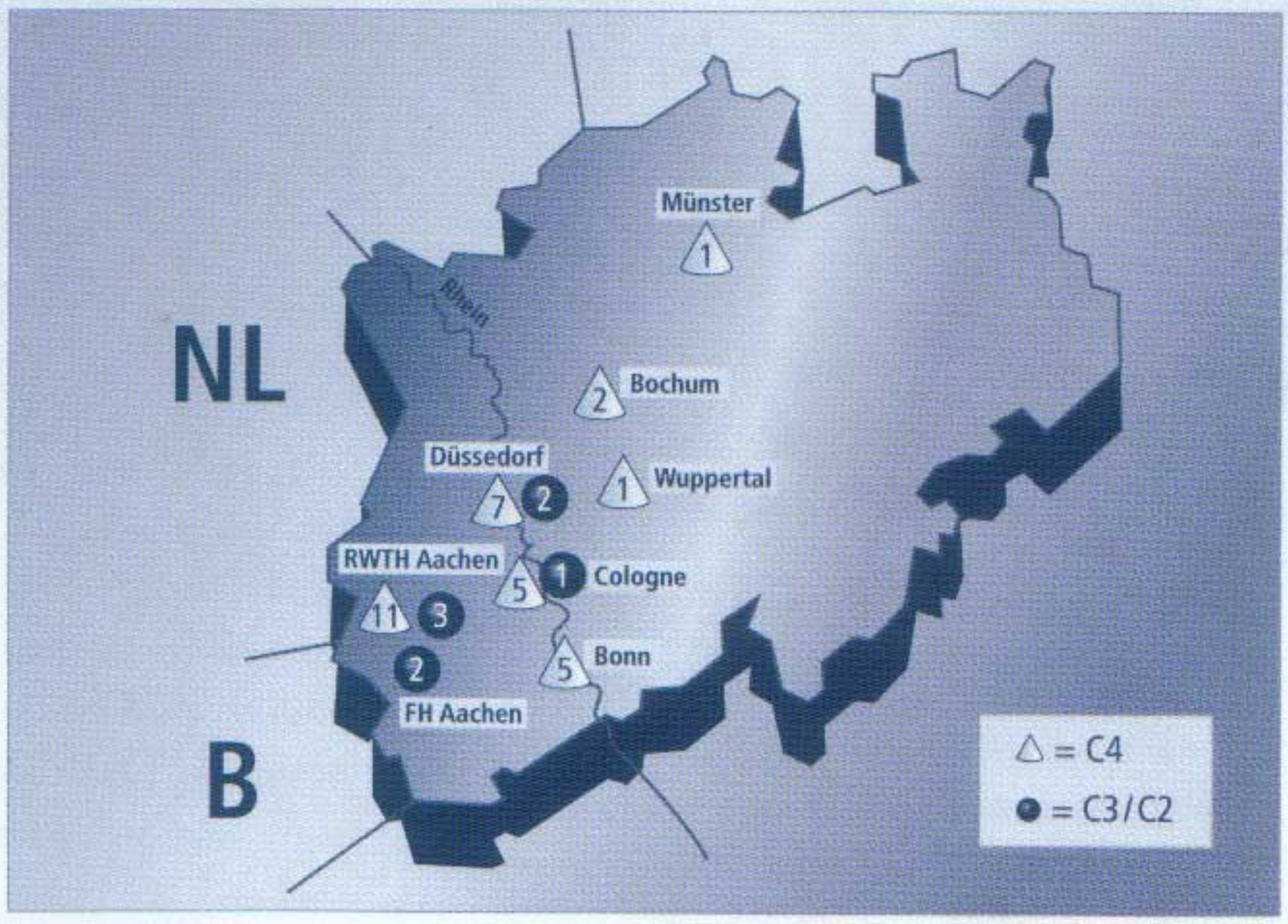
Training the New Generation

One opportunity here is to join a research group as a student assistant. Indeed, many of those who get to know the outstanding facilities and exciting research at Jülich in this way subsequently return to complete a degree or doctoral project.

There are currently around 100 degree students and 340 PhD students working at Research Centre Jülich. In total, 117 diploma dissertations and 114 PhD theses were completed in 2002. The majority of these young researchers come from local universities such as RWTH Aachen University and the Aachen University of Applied Sciences, or the Universities of Düsseldorf, Cologne and Bonn. But also, PhD students from as far away as Novosibirsk in Siberia find their way to Jülich.

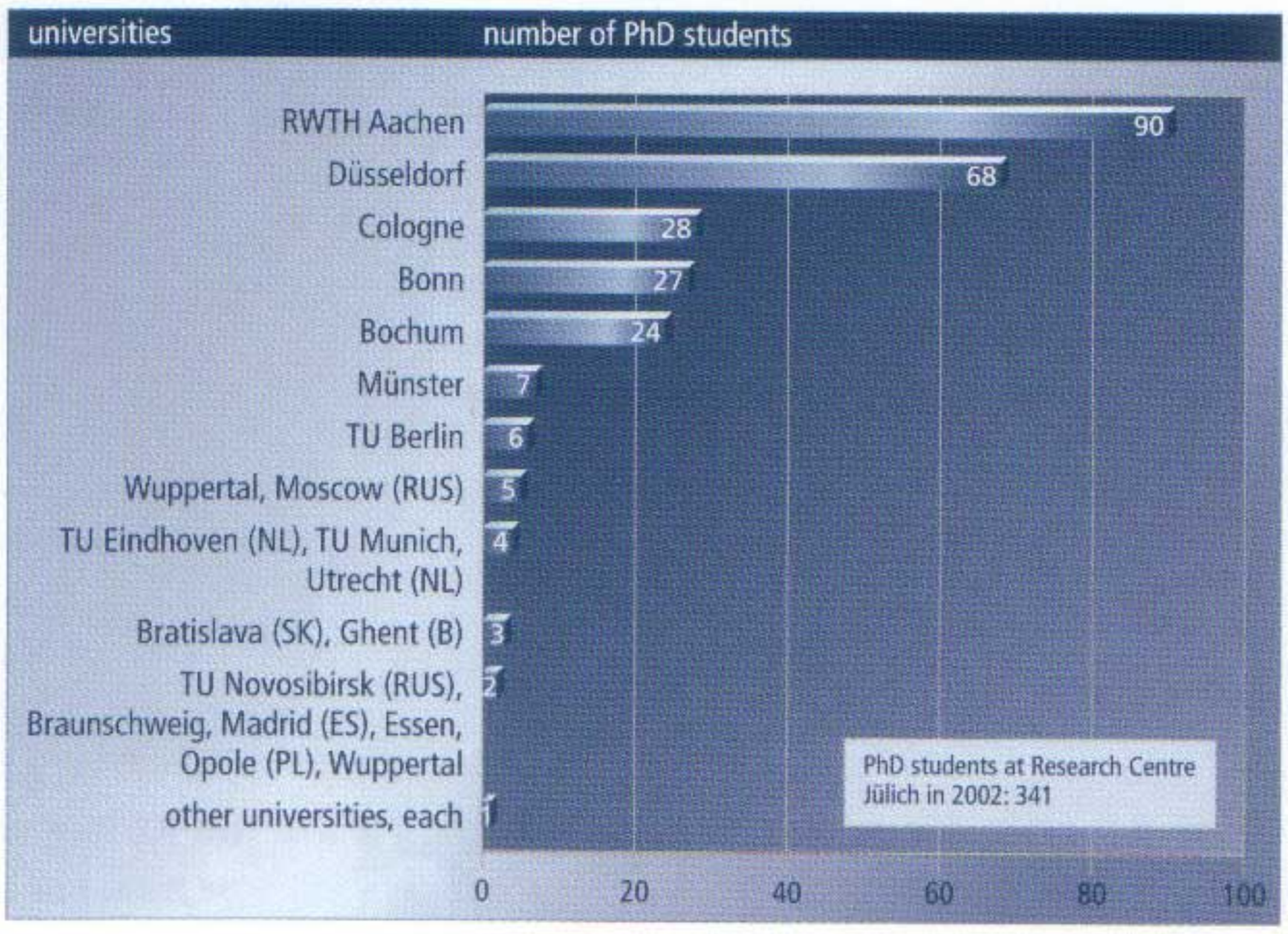
In addition, Jülich offers vacation courses every year. These feature lectures by internationally renowned scientists and provide a platform for students and young scientists to discuss the latest research developments. For example, the spring school "Fundamentals of

Joint appointments with universities in North Rhine-Westphalia

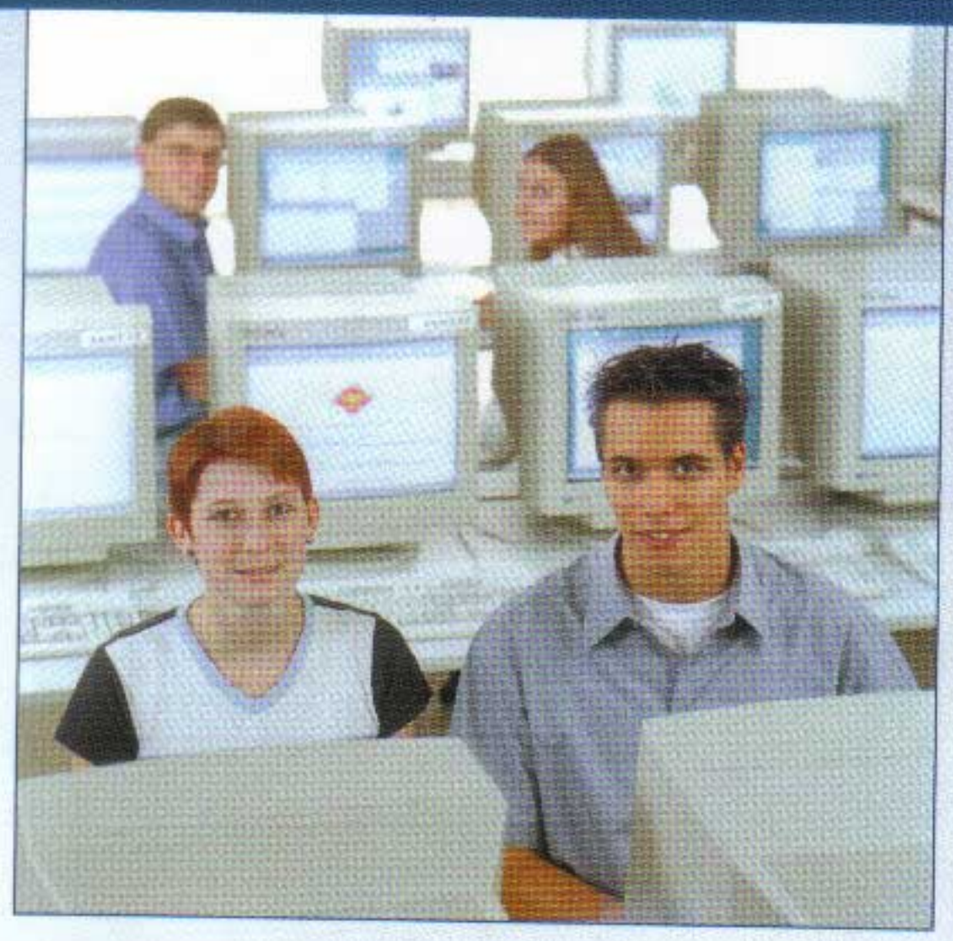


PhD students from German and foreign universities

at Research Centre Jülich in 2002



Training the New Generation



Mathematical-technical assistants at Jülich combine their training with a degree course.

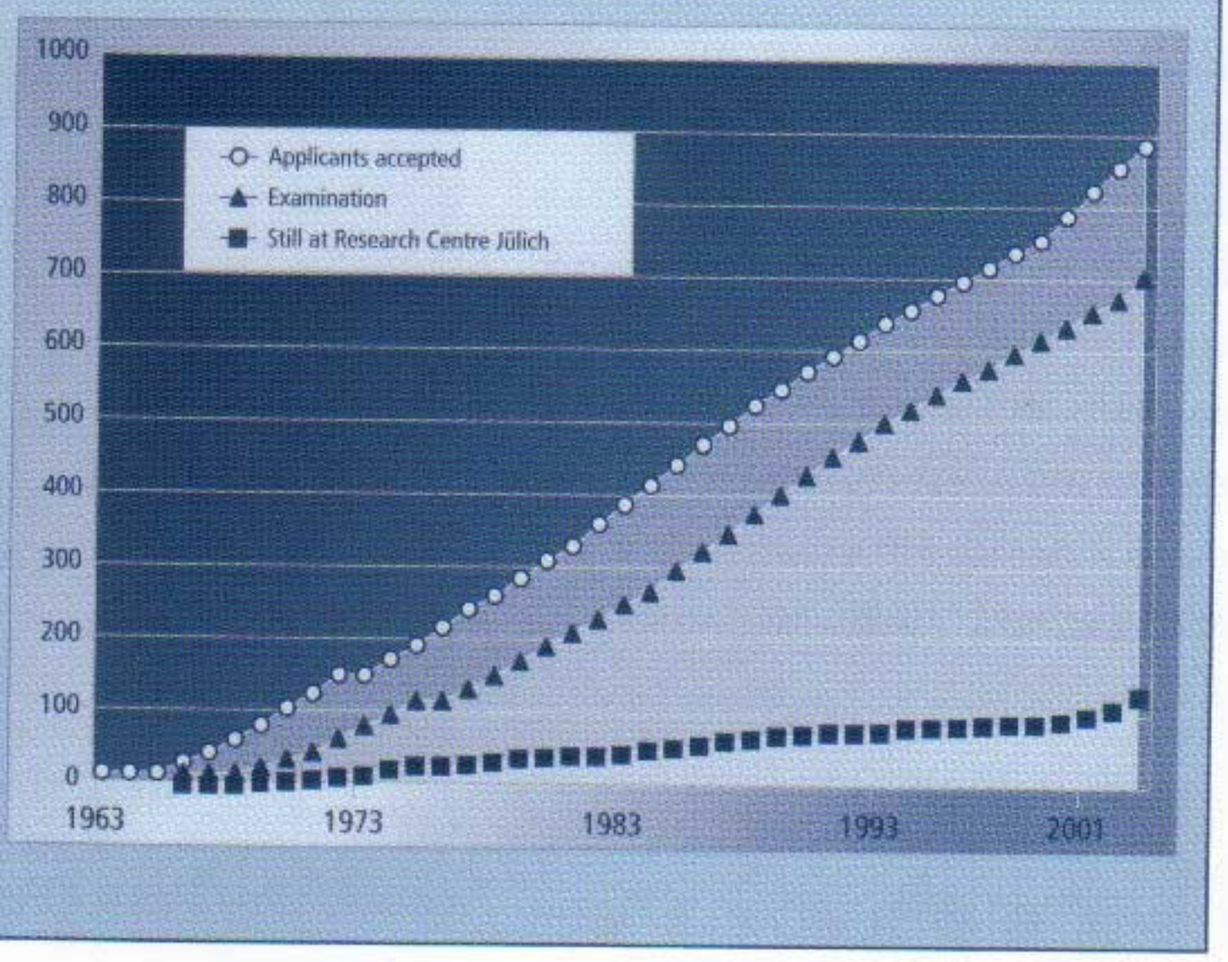
Nanoelectronics", held by the Institute of Solid State Research in 2003, attracted 269 students from 86 universities in 23 European countries. Likewise, the 2002 winter school at the John von Neumann Institute for Computing (NIC), which received EU funding from the programme "Improving Human Research Potential", drew 189 participants from 29 countries eager to learn about the subject of "Quantum Simulation". At Jülich, this combination of cutting-edge research and a commitment to higher education has proved to be a resounding success. ■

Training and Studying in One Package

School-leavers are often unsure whether to go to university or to train on the job . Yet why not do both? Working in close cooperation with Aachen University of Applied Sciences, Research Centre Jülich has developed a special vocational training programme with an accompanying degree course for sixth-formers with a gift for maths. As a result, young people training to become mathematical-technical assistants at Research Centre Jülich can now also do a course in technomathematics at Aachen University of Applied Sciences.

The training programme at the Research Centre lasts two and a half years. During this time, trainee mathematical-technical assistants attend classes jointly organised by the Research Centre and the university. The examination results count as credits for the university course. Those wishing to continue their studies after the final examination before the Chamber of Industry and Commerce can therefore go on to gain a degree in mathematics at Aachen University of Applied Sciences after another two years of study.

Training statistics for mathematical-technical assistants



International Science at Jülich

In August 2003 a delegation from Tongji University visited the Research Centre; the following October scientists from Jülich travelled to China. Within a few months, an agreement was reached regarding an ecological research project at the Three Gorges Dam.

Scientists need to be cosmopolitan. In many fields of research, international cooperation is the only way of achieving the critical mass required to produce outstanding results. Over the years, not only has Research Centre Jülich engaged in numerous research partnerships with universities around the world; in addition, its vast experience in managing international projects means it is ideally positioned to play an integrating role within the common European Research Area that is now taking shape.

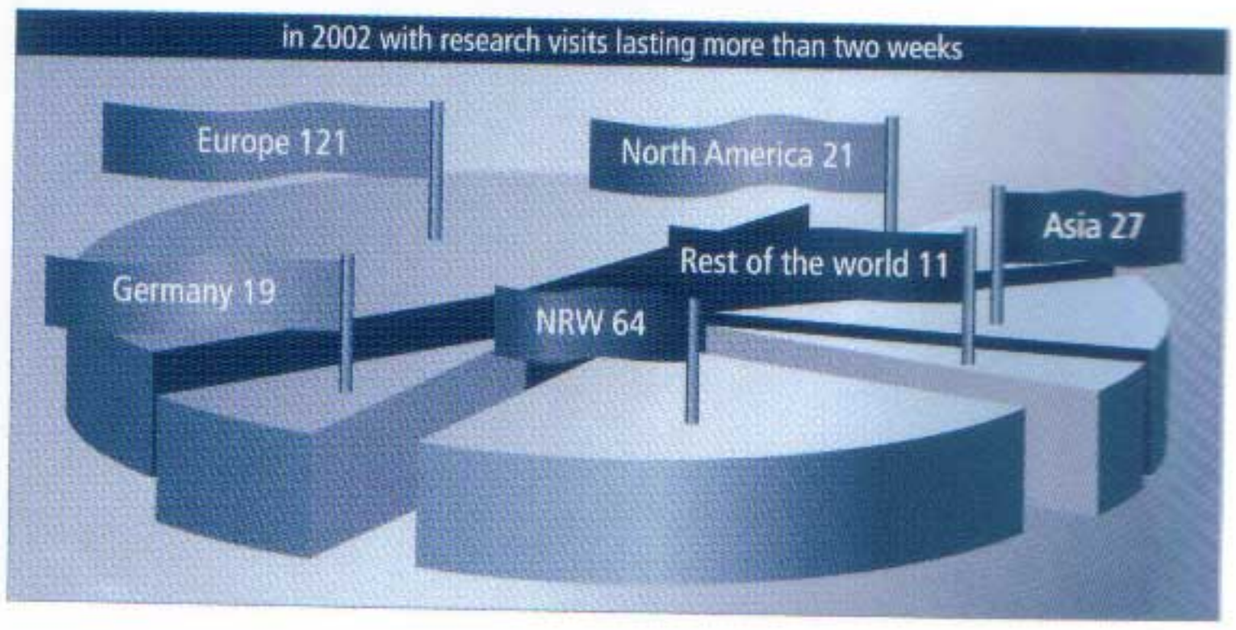
Research Centre Jülich is a major source of momentum in the campaign to create a new dimension of cooperation in European science. For example, collaborative research projects initiated by Jülich scientists have successfully applied for funds that the Sixth EU Framework Programme makes available for the new "Networks of Excellence" and "Integrated Projects". Among the cooperative research initiatives that fulfil such stringent requirements are projects in the field of materials science and fuel-cell technology (cf. pp. 18 and 22).

The favourite destination of Humboldt scholars

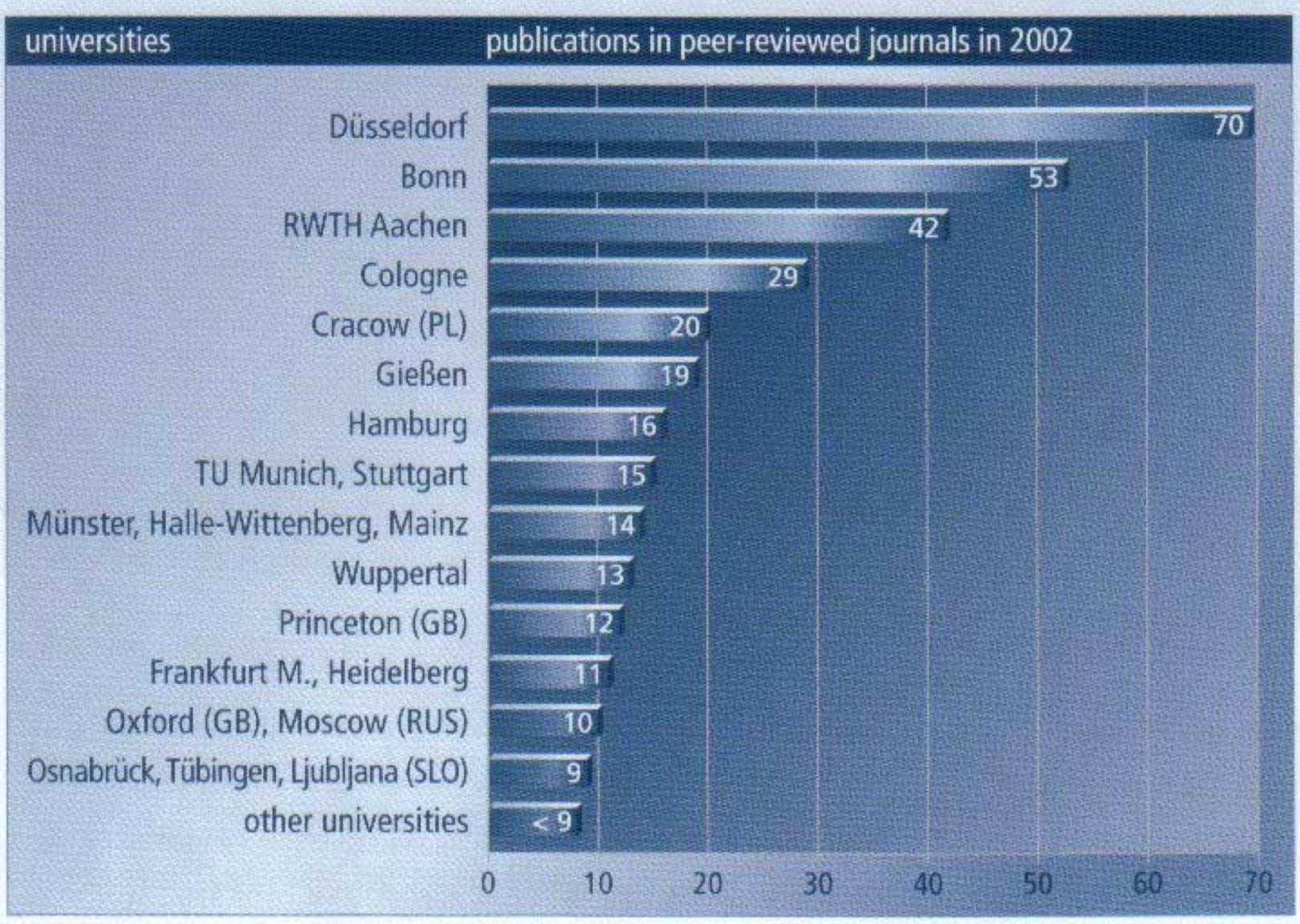
There is a permanent exchange of new ideas and concepts at Research Centre Jülich, which was host to some 850 visiting scientists from 50 countries in 2002. Of that total, 264 came from universities abroad and spent at least a fortnight in Jülich. We are particularly proud of the fact that so many fellows from the Alexander von Humboldt Foundation opt to spend their research time at Research Centre Jülich. Indeed, in a ranking list published by the Humboldt Foundation in 2003, the Research Centre was the most popular host institute of all non-university research establishments.

All in all, the Research Centre has cooperative links with more than 270 universities abroad. Of the 944 articles published by Jülich scientists in peer-reviewed journals in 2002, almost two-thirds were produced in collaboration with university researchers, and a large proportion of them were written together with scientists from foreign universities.

Visiting researchers from universities



Joint publications with universities



Science goes East

For over three decades now, Research Centre Jülich has had strong ties to universities in Poland, particularly the University of Cracow. At the end of 2002, a new co-operation agreement was signed with the Faculties of Physics and Biotechnology in Cracow, and a joint programme for PhD students agreed upon. Jülich also has close contacts with a number of Russian research institutes, especially in the field of physics, where a total of 20 joint projects were agreed upon in 2002 alone. Last year, scientists at Jülich also launched eight new projects with institutes from other Eastern European countries in the fields of environmental research, information technology and fuel-cell technology.

Further east, the Research Centre also has cooperation agreements with universities in the People's Republic of China. In summer 2003, as the flooding of the Three Gorges Dam was making headline news, Jülich researchers were putting together a joint project with scientists from the University of Shanghai to study the dam's impact on the environment. All in all, institutes from the Research Centre are currently cooperating with nine Chinese universities on a total of 18 joint projects.

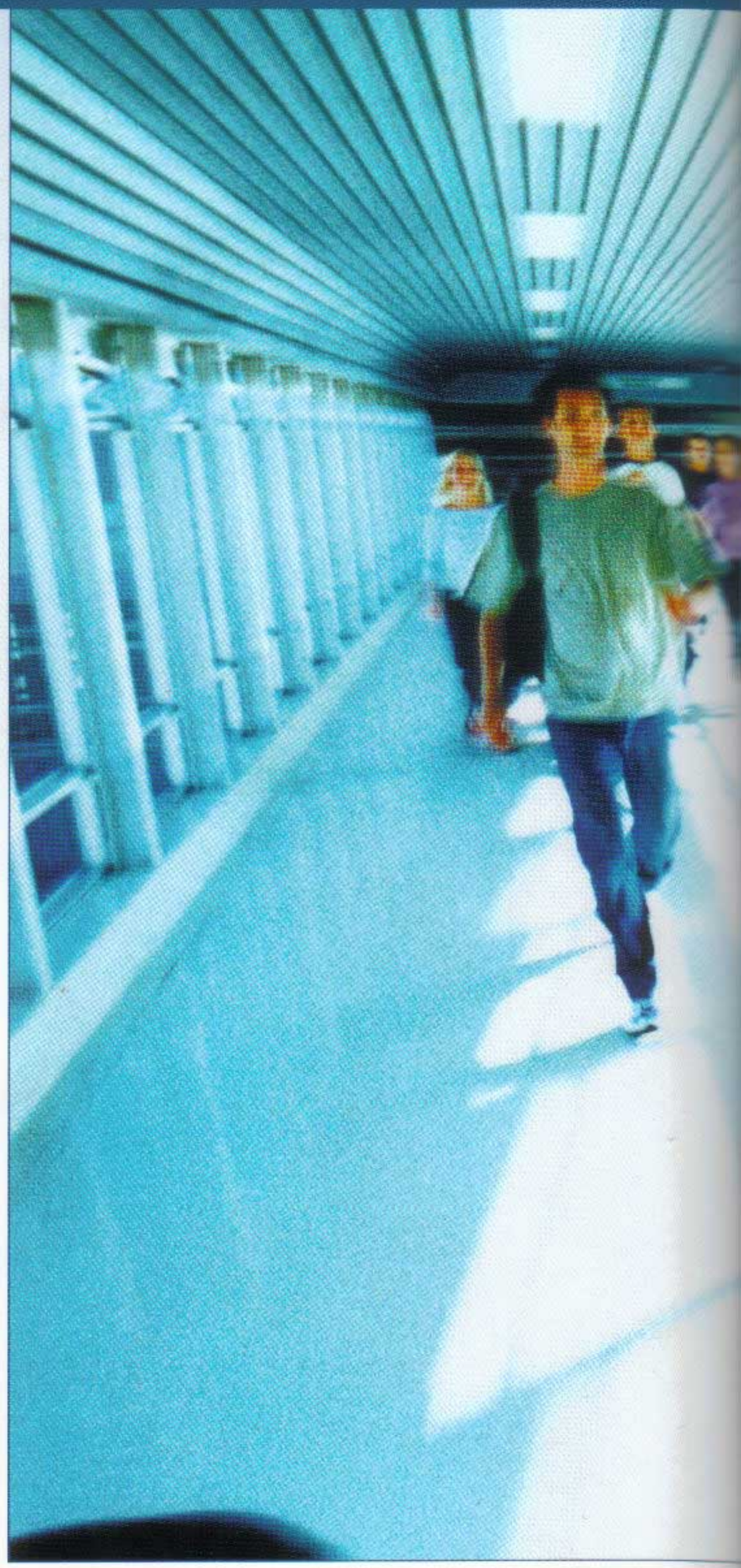
The Research Centre is also making intense efforts to attract young scientists from abroad. For example, Jülich scientists took part in a promotional tour of Russia in 2002, which was organised by the GATE-Germany Consortium for International University Marketing. Research Centre Jülich also attended recruitment fairs in France, Mexico and China. ■

Global science

Research Centre Jülich works together with universities worldwide.

(The figures show the number of cooperations with university institutes in each country.)

Forschungszentrum Jülich
in der Helmholtz-Gemeinschaft



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