Fraunhofer

60 YEARS OF FRAUNHOFER-GESELLSCHAFT

60 YEARS OF FRAUNHOFER-GESELLSCHAFT

FOREWORD

Ladies and gentlemen,

At Fraunhofer we are used to focusing our sights on the future. Not least because applied research is geared toward widening the scope of opportunities for progress. We measure ourselves in terms of market success, and therefore need to know what customers will expect from us the day after tomorrow.

Our future achievements will be derived from the knowledge we have gleaned in the past. We therefore intend to make use of our 60th anniversary as an occasion to look back and review the remarkable history of the Fraunhofer-Gesellschaft. At the same time we will be looking ahead, demonstrating the kind of commitment that enables our staff to keep Fraunhofer forever young.

The Fraunhofer story – something you realize all too readily reading the historical background in this brochure – is unparalleled in Germany. Founded in 1949, the organization consisted of little more than a handful of employees and a few honorary members in the early days. Back then, nobody could foresee that applied research – and in turn Fraunhofer too – would flourish in quite such a way. Five years after its foundation, the first Fraunhofer Institute was opened, as Germany's "economic miracle" gave rise to a growing need for industrial research.

After a checkered history marred by a systemic lack of funding, the breakthrough came in the 1970s with institutional funding from central government and the *Länder*. The key milestone saw the introduction of a new form of research financing: The "Fraunhofer model" essentially states that for every euro Fraunhofer earns from contract research, the federal government will match with a euro of base funding. This ensures that government support ends up where it works most effectively – in commercially relevant projects. This mode of financing provided a powerful impetus to the growth of the Fraunhofer-Gesellschaft. The foundation or integration of many application-related research institutes ultimately made the Fraunhofer-Gesellschaft what it is today.

Focusing on future markets has always been an essential part of our success. This principle remains unchanged, and is precisely the reason why Fraunhofer, after 60 years, is more dynamic today than ever before. Particularly in the research-intensive high-tech segment, markets are witnessing an increasing rate of change. Nonetheless, research in the Fraunhofer Institutes is not only keeping up but in many cases actually setting the pace. The current technological lead held by many German companies can be attributed in no small measure to Fraunhofer.

To preserve this lead, Fraunhofer is making targeted investments in frontline research and systematically developing key technologies. 60 years of dedication to the future represents a commitment that we still assume today, helping Germany to maintain its profile as a top industrial nation and serving as the powerhouse behind innovation to ensure that German industry can continue to inject a fresh dose of added momentum and dynamism.

Sincerely,

Hans-Jörg Bullinger
President of the Fraunhofer-Gesellschaft

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1

1954

60 YEARS OF FRAUNHOFER-GESELLSCHAFT: A SUCCESS STORY

Foundation, orientation, assertion – the early years of the Fraunhofer-Gesellschaft

1949, 1950

The Fraunhofer-Gesellschaft was founded on March 26, 1949 in Munich, as part of the reorganization and expansion of the German research infrastructure. In its early years, the main function of the non-profit organization was essentially administrative: To raise funding through government bodies, donations and association members for allocation to industrial research projects.

Initial activities focused primarily on industry in Bavaria. In tune with the needs of the early post-war period, research focused on the fields of mining, the iron and steel industry and mechanical engineering.

The renowned nuclear physicist Walther Gerlach acted as president of the Fraunhofer-Gesellschaft for the first two years, whilst retaining his post as rector of the University of Munich.

1951

The Fraunhofer-Gesellschaft was granted research funding for the first time from the Marshall plan through the European Recovery Program (ERP), testimony to the organization's acceptance within government circles.

Wilhelm Roelen took over as Fraunhofer president, a man with industrial experience. He was also director-general of the Thyssensche Gas- und Wasserwerke AG.

1 *The first Fraunhofer-Gesellschaft research institution was the Fraunhofer Institute for Applied Microscopy, Photography and Cinematography IMPK founded in 1954.*

i Charles Ginsburg, working for Ampex, developed the video recorder, a device for magnetic recording of picture and sound signals.

" By today's standards, the Ampex video recorder was a huge appliance. Thanks to state-of-the-art semiconductor technology and compression techniques, we can now transmit video and music using devices that easily fit into a pants pocket. We are proud that our technology is utilized today in many devices that compress image and audio signals. "
Prof. Dr. Thomas Wiegand, head of department at the Fraunhofer HHI, was one of the original designers of the H.264 video encoding standard, used today in many applications including HDTV, Blu-ray Disc, Internet and mobile TV, video-enabled iPods and iPhones.

1952

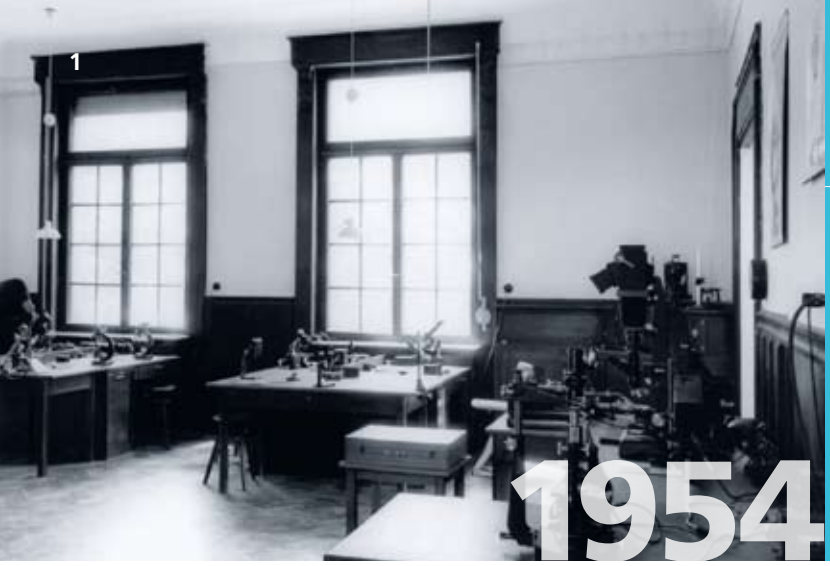
At a meeting attended by representatives of the German federal ministry of economics, the role of the Fraunhofer-Gesellschaft was formally recognized as the third pillar in the German research infrastructure, alongside the Deutsche Forschungsgemeinschaft (DFG) and the Max-Planck-Gesellschaft (MPG).

August Epp joined the Fraunhofer-Gesellschaft as commercial clerk. He later moved up to become managing director, secretary-general and ultimately member of the Executive Board.

i National long-distance dialing, for which Siemens had been developing the technology since 1923, was introduced in the West German telephone network.

1953

A serious crisis was spawned by the initial resistance and competition from other national research organizations, which came to a head in the following year. The remit and working practices of the Fraunhofer-Gesellschaft were still not sufficiently clearly defined.



1

1954

{1954}
THE FRAUNHOFER-GESELLSCHAFT CONSISTED OF JUST A HANDFUL OF PERMANENT STAFF. ALL OTHER FUNCTIONS WERE FULFILLED ON AN HONORARY BASIS.

The foundation of a German office of the U.S. Battelle Memorial Institute was initially perceived as a threat to the survival of the Fraunhofer-Gesellschaft since this renowned institution had been carrying out applied research with a great deal of success. Ultimately, however, the competition proved to be a stimulus to the development of the Fraunhofer-Gesellschaft.

1954

The Fraunhofer-Gesellschaft fought for its survival. In the established German scientific community, there was already talk of dissolving the organization. But thanks to the financial and political support from the *Länder* of Bavaria and Baden-Württemberg in particular, the Fraunhofer-Gesellschaft managed to pull through this difficult situation, and finally gained the undisputed right to operate on a national basis as an applied research organization, with its own staff and on its own research and development projects.

The first of its own research institutions was founded in Mannheim: the Fraunhofer Institute for Applied Microscopy, Photography and Cinematography IMPK. It had a staff of seven.

„Accompanying and supporting the institutes as they move into new research areas is exciting. We have been dealing with certain markets and visions for a long time: 'Cinematography' formed part of the name of the first Fraunhofer Institute launched back in 1954. Today the Fraunhofer Network for Digital Cinema is successfully developing techniques for 3-D sound and vision for tomorrow's cinema." *Dr. Beate Rauscher, Fraunhofer-Gesellschaft, Research Planning.*

i U.S. company Texas Instruments launched the first transistor radio on the market in the form of "Regency". And the Bell Telephone Laboratory in the USA developed the silicon photovoltaic cell, which converts light energy directly into electricity.

Integration into the German scientific community

1955

Encouraged by the general atmosphere of economic revival, private industry increased its investment in research and development to a total of 600 million marks. The onset of the German "economic miracle" improved market opportunities for the Fraunhofer-Gesellschaft.

The Fraunhofer-Gesellschaft Patent Center for German Research PST in Munich opened its doors.

Hermann von Siemens embarked on nine years of successful work as president of the Fraunhofer-Gesellschaft, ably assisted by his energetic vice-president Albert Maucher.

i Xerox produced the first automatic photocopying machine designed to use plain paper.

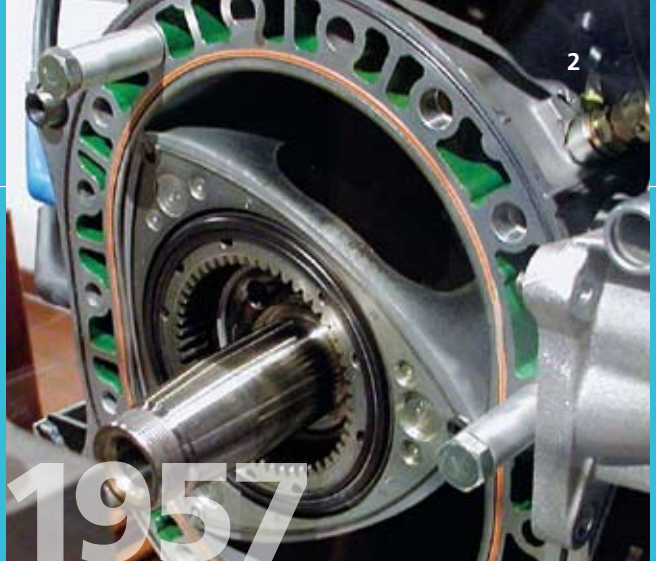
1956

The foundation of institutes forged ahead: The Fraunhofer Institute for Hygiene and Bacteriological Work Procedures IhbA in Munich was established, and the Fraunhofer Institute for Xyolite Research ISF in Bonn was integrated.

With the support of the German ministry of defence, created one year earlier, the Fraunhofer-Gesellschaft now also took on responsibility for projects in the area of defense research. This proved to be of great benefit to the organization's further growth, providing a second major source of revenue alongside contract research. For many years, military funding accounted for more than half of the Fraunhofer-Gesellschaft's total research budget. The shared use of defense resources for civilian projects helped assure the financial future of the Fraunhofer-Gesellschaft.

{1959}

TEN YEARS AFTER IT WAS FOUNDED, THE FRAUNHOFER-GESELLSCHAFT BOASTED 9 INSTITUTES OF ITS OWN. A WORK-FORCE OF 135 GENERATED REVENUES OF 3.6 MILLION MARKS.



For the first time, Fraunhofer formally expressed its interest in receiving institutional base funding from public sources, such as already granted to other German research institutions, thus providing support for the further expansion of its activities.

1957

i German engineer Felix Wankel successfully tested his three-stroke rotary piston engine.

i The Advanced Research Project Agency (ARPA) was founded in the USA, with the aim of building a secure military computer network. The packet switching transmission system later laid the foundation for the Internet.

The Fraunhofer Institute for Electrical Materials IEW in Freiburg, later renamed the Fraunhofer Institute for Applied Solid State Physics IAF, and the Test and Research Institute for Shoe Manufacture Ish in Pirmasens started their work.

1958

Two new Fraunhofer research institutions were created: The Documentation Center for Radiochemistry DRc in Munich and the Technical Committee for Aerosol Studies FAe in Bad Lippspringe. The Test and Research Institute for Shoe Manufacture Ish ceased its activities.

1 *Research facilities at Fraunhofer IMPK.*

2 *Felix Wankel developed the rotary piston engine. He would later become director of the Technical Development Center Lindau TES at the Fraunhofer-Gesellschaft.*

" Research conducted by scientists at the Fraunhofer Institute for Building Physics IBP contributes substantially to solving emerging environmental problems while also directly improving people's lives. Passing on my enthusiasm to colleagues and students and supporting them so they can assume responsibility for identifying and taking advantage of the opportunities open to them, is a role that makes what I do extremely worthwhile. " *Prof. Dr. Klaus Sedlbauer's first contact with the Fraunhofer IBP was as a student. Today he is the institute's director.*

i U.S. company Texas Instruments manufactured the first semiconductor integrated circuit.

1959

In 1959, the Fraunhofer-Gesellschaft inaugurated three new institutions: the Institute for Aerobiology IAe in Schmallenberg, the Ernst-Mach Institute for High-Speed Dynamics EMI in Freiburg and the Pfinztal-based Institute for Chemical Technology ICT. The latter two research institutions initially worked exclusively on contracts for the ministry of defence. The Institute for Technical Physics ITP, later renamed the Fraunhofer Institute for Building Physics IBP, was integrated.

" In April 1959, we set up our first headquarters in a disused quarry. After a 15-year break in explosives research we had to painstakingly collate our wealth of knowledge. The positive impression that an assistant of Wernher von Braun took away from the ICT also then helped us secure funding for a new building. By the end of the 1960s, the ICT had become the largest Fraunhofer Institute. " *Prof. Dr. Hiltmar Schubert, employee since its foundation in 1959 and director of the Fraunhofer ICT from 1970 to 1993.*

{1964}

IN THE FIFTEENTH YEAR OF ITS EXISTENCE, THE FRAUNHOFER-GESELLSCHAFT CONSISTED OF 19 INSTITUTES AND A CENTRAL ADMINISTRATION. 700 STAFF NOW GENERATED REVENUES TOTALING 16 MILLION MARKS.

1

1960

In Stuttgart, work started at the Documentation Center for Structural Durability DTB, later renamed the Fraunhofer Information Center for Regional Planning and Building Construction IRB.

i The first laser device was produced in the USA.

1961

i German engineer Walter Bruch developed the PAL system for color television.

1962

The new research establishments to join the Fraunhofer-Gesellschaft in 1962 included: the Fraunhofer Institute for Structural Durability LBF in Darmstadt; the Fraunhofer Institute for Interfacial Physics and Chemistry IGf, which later moved to Stuttgart and was renamed the Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB; the Technical Development Center Lindau TES, run by engine builder Felix Wankel; the Physical and Bioclimatic Research Center PBF in Garmisch-Partenkirchen, which subsequently became the Fraunhofer Institute for Atmospheric Environmental Research IFU; the Working Group for High-Pressure Plasma Physics and Pulse Discharge Physics AGD in Erkrath.

1963

i MOS technology was developed, providing a low-cost method of manufacturing highly complex semiconductors with a high packing density.

The Fraunhofer Institute for Radiometeorology and Maritime Meteorology IRM was inaugurated in Hamburg.

1964

The Technical Committee for Aerosol Studies FAe was disbanded.

In December, Hermann von Siemens relinquished the still honorary function of president to Franz Kollmann, who retained his post as professor of wood research at the Technical University of Munich.

1965

The politically influential German Science Council recommended general expansion of non-academic research institutions and the Fraunhofer-Gesellschaft in particular as the umbrella organization for applied research. Government decision-makers, however, made this dependent on structural reforms and the creation of a substantial development program for the Fraunhofer-Gesellschaft.

" Without any ties to a large organization, the institute's survival was thrown into question once I'd reached retirement age. It proved a twist of fate that the German government decided to establish the Fraunhofer-Gesellschaft as the representative of application-oriented research. We were thrilled when in 1970 a committee to promote the expansion of the Fraunhofer-Gesellschaft suggested we join the organization. The integration took several years and proved difficult, but has proven to be spot on when it comes to ensuring research content and jobs. " *Prof. Dr. Rudolf Heiss, since its foundation and through 1975 director of the Fraunhofer Institute for Food Technology and Packaging ILV, now the Fraunhofer Institute for Process Engineering and Packaging IVV.*

1 *Test card for the PAL system for color television.*
2 *Fraunhofer president Franz Kollmann (left).*
3 *Test equipment from the Research Group for Hydroacoustics FgHA.*

1965

{1969}
AFTER TWENTY YEARS, MORE THAN 1200 STAFF WERE EMPLOYED AT THE FRAUNHOFER-GESELLSCHAFT. THE TOTAL BUDGET WAS NOW 33 MILLION MARKS.

The Research Group for Hydroacoustics FgHA in Ottobrunn started work.

i Rudolf Hell developed the Digiset system, a computer-controlled photoelectronic typesetting process.

New directions and expansion

1966

i Peter Sorokin in the USA and Fritz Peter Schäfer in West Germany invented the dye laser simultaneously.

1967

The Fraunhofer Institute for Oscillation Research IsF was set up in Karlsruhe. It later became the Fraunhofer Institute for Information and Data Processing IITB.

1968

The Fraunhofer Institute for Floor Covering Research and Materials Testing IFM, formerly IfS, was hived off from the Fraunhofer-Gesellschaft.

Research minister Gerhard Stoltenberg set up a "committee to promote the expansion of the Fraunhofer-Gesellschaft".

In October 1968, Otto Mohr took over as Fraunhofer president.

The student movement threw West Germany into turmoil. Fraunhofer attracted fierce criticism for its involvement in defense research. In some cases, the police had to be called in to prevent student sit-ins in the institutes.

The situation is compounded by the Petras incident: an employee of the Grafschaft Fraunhofer Institute for Aerobiology IAe, Ehrenfried Petras, defected to the German Democratic Republic, where he publicly claimed that the Fraunhofer-Gesellschaft was participating in preparations for ABC warfare.

" Who could forget 1968? The assassination of Martin Luther King and the depressing developments in the Vietnam War. Just as I was embarking on my math dissertation at the University of Bonn, I'd often face the dilemma: 'Would it be the demo or the library?' Today I'm happy the library won out on the whole and my love of math prevented me from getting involved in other things. " *Prof. Dr. Heinz-Otto Peitgen played a part in raising the profile of fractal geometry and chaos theory around the world. In 1995, he founded the MeVIS – Center for Medical Diagnostics Systems and Visualization at the University of Bremen, later to become MeVis Research GmbH, holding the post of managing director to this day. MeVis Research became another institute in the Fraunhofer-Gesellschaft in early 2009.*

1969

The Working Group for Physical Space Research APW started work; it would later be renamed the Fraunhofer Institute for Physical Measurement Techniques IPM. The Documentation Center for Radiochemistry DRc in Munich was closed.

Fraunhofer was included in the government base funding scheme.

1 *The Digiset system for the photoelectronic typesetting process.*
2 *The Fraunhofer Institute for Silicate Research ISC in Würzburg.*

1970

The Fraunhofer Institute for Manufacturing Engineering and Automation IPA in Stuttgart, which hitherto had been under the administration of Fraunhofer, was integrated. The Working Group for Applied Materials Research AFAM in Bremen was founded; it was then integrated as the Fraunhofer Institute for Applied Materials Research IFAM in 1974.

The "government committee to promote the expansion of the Fraunhofer-Gesellschaft" presented its recommendations. The report included lists of potential future Fraunhofer Institutes along with conceptual and organizational changes. Proposed measures included a scheme to coordinate preliminary research, contract research and research projects, a balanced regional distribution of institutes, the creation of focal activities based on their geographic and thematic proximity, and the introduction of performance-based remuneration.

A joint committee made up of members of the German research ministry and the Fraunhofer-Gesellschaft was inaugurated and tasked with drawing up detailed plans for the expansion of the organization.

1971

The new Fraunhofer-Gesellschaft statute envisaged assigning greater powers to the Senate and a substantial reinforcement of the three-strong Executive Board, whose functions became fully professional and no longer honorary. This represented a move toward organizational structures more closely aligned to those in industry. Each Fraunhofer Institute was assigned a specific area of research.

Three new research institutions came into being: The Institute for Solid-State Mechanics IFKM was founded in Freiburg as an offshoot of the Ernst-Mach Institute for High-Speed Dynamics EMI, later becoming the Fraunhofer Institute for Mechanics of Materials IWM. The Institute for Silicate Research ISC in Würzburg was taken over from the Max Planck Society, and the Documentation Center for Water DZW was inaugurated in Düsseldorf.

Introduction, testing and impact of the Fraunhofer model

1972

The joint planning committee for research and expansion presented its first draft report, which proposed the idea of the so-called "Fraunhofer model". The model envisaged increasing government base funding as a function of the Fraunhofer-Gesellschaft's success in acquiring contract research work. This meant that research and development work had to be oriented strictly in accordance with the market.

From now on, the pay scale for permanent staff was brought fully in line with the German official pay scale for civil servants and white-collar workers (Bundesangestelltentarifvertrag, BAT). This reduced the organization's competitiveness vis-à-vis industry in seeking qualified staff in the labor market.

In February, the general works council of the Fraunhofer-Gesellschaft held its founding session. Rudolf Zapp was elected its first chairman.

The nuclear safety program introduced by the German ministry of research in 1971 led to the first cross-institute cooperation with Fraunhofer.

The year brought about considerable changes in existing Fraunhofer Institutes: New additions included the Institutes for Non-Destructive Testing IZFP in Saarbrücken, for Systems and Innovation Research ISI in Karlsruhe, for Wood Research, Wilhelm-Klauditz-Institut, WKI in Braunschweig and for High-Voltage Electron Microscopy IHEM in Karlsruhe. The latter, however, together with the Technical Development Center Lindau TES, left the Fraunhofer-Gesellschaft in the same year.

1973

{1974}

ON ITS 25TH ANNIVERSARY, THE FRAUNHOFER-GESELLSCHAFT COULD LOOK BACK AT AN IMPRESSIVE RECORD. WITH A STAFF OF NEARLY 1700, THE ASSOCIATION'S TOTAL BUSINESS VOLUME NOW FOR THE FIRST TIME EXCEEDED 100 MILLION MARKS.

1973

The offices of the Executive Board and central administration, until now spread across nine buildings in the Nymphenburg district of Munich, moved under a single roof, at Leonrodstrasse 54. The increased powers and staffing of the central organization, required under the new policy, led to conflicts with the institutes, who feared for their autonomy; these conflicts were only gradually laid to rest over the following years.

A cabinet decision approved in principle the structures of the "Fraunhofer model", enabling the introduction of largely results-dependent base funding and a supplementary support fund administered independently by the organization's Executive Board. This served to confirm, among other things, that government decision-makers firmly intended to transform the Fraunhofer-Gesellschaft into the leading umbrella organization for applied research institutes. At the same time, the association gained the flexibility to respond as required to changing overall conditions in the scientific community and in the market for contract research. Over the next few years, the new settlement led to permanent and sustained growth of the Fraunhofer-Gesellschaft.

In a departmental agreement between the ministries of research and defence, together with the Fraunhofer-Gesellschaft, it was agreed to open up the military-oriented institutes for civilian research.

In October, Heinz Keller, formerly member of the board of Vereinigte Metallwerke Ranshofen-Berndorf, took over the post of president, while Eberhard Schlephorst was nominated the first full-time Executive Board member for legal and personnel affairs.

1 *Fraunhofer president Heinz Keller.*
2 *The first space probe on Mars: Viking 1.*

The Fraunhofer Institute for Food Technology and Packaging ILV in Munich joined the association. It was later renamed the Fraunhofer Institute for Process Engineering and Packaging IVV.

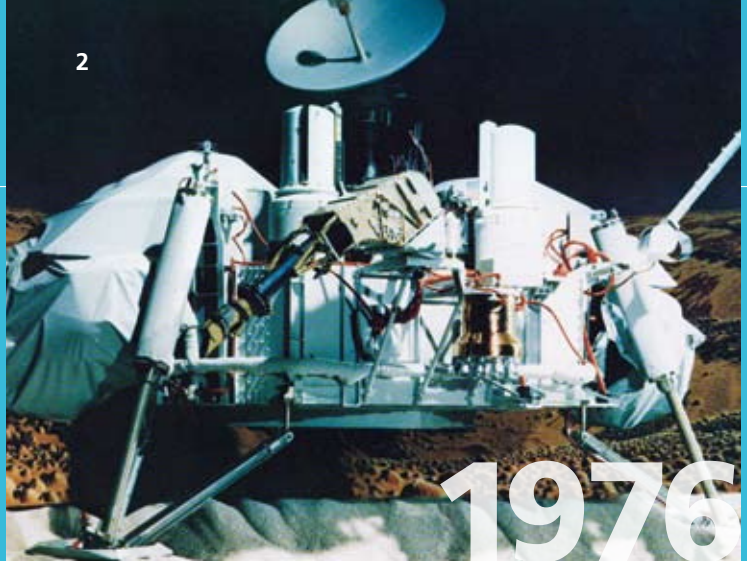
1974

The optimistic mood at the Fraunhofer-Gesellschaft was reinforced by a reshuffle of the Senate: Its new members came from a wide variety of backgrounds, such as the social scientist Walter H. Goldberg, journalist Marion Gräfin Dönhoff and trade union leader Franz Steinkühler.

" Opening up the Senate to a wide variety of backgrounds has proved to be the right strategy. The different perspectives provide impetus but also cause friction, forcing people to take a new look at technical innovations and societal problems. Such perspectives prevent blind spots in our self-perception. As a social scientist, I am fascinated by the debates that emerge in the tussle between technology, innovation policy and academic federalism. " *Prof. Dr. Barbara Pfetsch, Institute for Media and Communication Studies of the Free University of Berlin, a member of the Fraunhofer Senate since 2004.*

New establishments in this year included the Fraunhofer Institute for Solid State Technology IFT in Munich and the Fraunhofer Institute for Technological Trend Analysis INT in Euskirchen.

i U.S. company Hewlett-Packard launched the first programmable pocket calculator.



1975

The Science Council produced a new evaluation of the Fraunhofer-Gesellschaft, but its effects were nowhere near as significant as those of 1965.

The proportion of military research in the overall budget of the Fraunhofer-Gesellschaft had fallen from over 50 percent at the end of the 1960s to nearer a quarter.

1976

The Fraunhofer program to promote contract research for small and medium-sized enterprises was initiated. The availability of government funding for the projects considerably improved the Fraunhofer-Gesellschaft's chances of securing new contracts.

The ministry of defence demanded the organizational and financial separation of parts of the institutes involved in defense research from the civilian project departments.

The existing institutes were divided into three categories: military research, contract research and joint services.

In Berlin, a department of the Fraunhofer Institute for Manufacturing Engineering and Automation IPA was hived off to form the Fraunhofer Institute for Production Systems and Design Technology IPK. The Hamburg-based Research Group for Radio Meteorology IRM and the Fraunhofer Institute for Applied Hygiene IaH in Munich were closed down.

i The U.S. space probe Viking I made a soft landing on Mars, transmitting pictures and measurement data back to Earth.

1977

The government's framework agreement on research funding came into force for the Fraunhofer-Gesellschaft. Under the terms of this agreement, the research and defence ministries were to share political responsibility for Fraunhofer, and funding support for civilian research was to be provided by the federal government and the *Länder* in a ratio of 9:1.

Hans-Ulrich Wiese was appointed as a member of the Executive Board with responsibility for finances, replacing August Epp.

i X-ray computer tomography made its debut in clinical medicine.

1978

The Fraunhofer program to promote contract research for small and medium-sized enterprises, initiated in 1976, grew into a nationwide government program for SME support. This program was to become a major growth and prestige factor for Fraunhofer.

The statute was changed and the administrative council was dissolved. Its duties under the articles of association were passed to the Executive Board and the Senate respectively.

The Fraunhofer Technology Development Group TEG started work in Stuttgart.

At the request of the regional government, the Freiburg-based Fraunhofer Institute for Solar Research – which did not form part of the Fraunhofer-Gesellschaft – adopted the name Kiepenheuer Institute for Solar Physics (KIS). This created the legal precedence allowing the Fraunhofer-Gesellschaft to refer to all of its institutions in a uniform manner as "Fraunhofer Institute".

The "Joseph von Fraunhofer Prize" was inaugurated. It is awarded annually to members of staff of the Fraunhofer-Gesellschaft for outstanding scientific work in the application-related solution of technical and scientific problems.

1

{1979}

30 YEARS AFTER ITS FOUNDATION, THE FRAUNHOFER-GESELLSCHAFT COMPRISED 27 RESEARCH INSTITUTES. THEIR 2200 EMPLOYEES GENERATED A BUSINESS VOLUME CLOSE TO 187 MILLION MARKS.

"We managed to combine light collectors made of a fluorescent material with liquid crystal cells to make large-format, brilliant displays. The technology was ideal for large clocks and displays. To receive the first Fraunhofer Prize for our work was an honor; I was absolutely delighted. The combination of fluorescent light collectors with photovoltaic cells also subsequently led to the creation of the Fraunhofer Institute for Solar Energy Systems ISE as an offshoot of our institute." Dr. Günter Baur, Fraunhofer IAF, first winner of the Joseph von Fraunhofer Prize in 1978.

i Two Russian and two U.S. space probes reached Venus and succeeded in sending back data.

1979

i The first European ARIANE rocket took off from French Guiana on its maiden flight.

1980

The Fraunhofer Institute for Production Technology IPT was founded in Aachen. The very first Fraunhofer Institute, the Institute for Applied Microscopy, Photography and Cinematography IMPK, ceased to operate in the same year.

The increasing demand for solar research as a result of growing environmental awareness and the energy crises led to the establishment of the Working Group on Solar Energy Systems ASE. It was later renamed the Fraunhofer Institute for Solar Energy Systems ISE.

i IBM built the first Personal Computer (PC).

1 *U.S. space shuttle Columbia on the launch pad.*

2 *Power test for solar modules.*

1981

In Dortmund, the Fraunhofer Institute for Transport Technology and Goods Distribution ITW was opened, later known as the Fraunhofer Institute for Material Flow and Logistics IML. The Fraunhofer Institute for Industrial Engineering IAO was devolved from the Fraunhofer Institute for Manufacturing Engineering and Automation IPA in Stuttgart.

i The first music CDs appeared on the market.

i The U.S. space shuttle Columbia took off on its maiden flight.

1982

i Positron emission tomography was demonstrated, allowing internal physical examinations of the whole body to be performed without X-rays.

The Fraunhofer Institute for Microelectronic Circuits and Systems IMS was founded. The department for microstructure technology of the Fraunhofer Institute for Solid State Technology IFT was transformed into the Fraunhofer Institute for Microstructure Technology in Berlin, and in 1994 moved to Itzehoe as the Fraunhofer Institute for Silicon Technology ISIT.

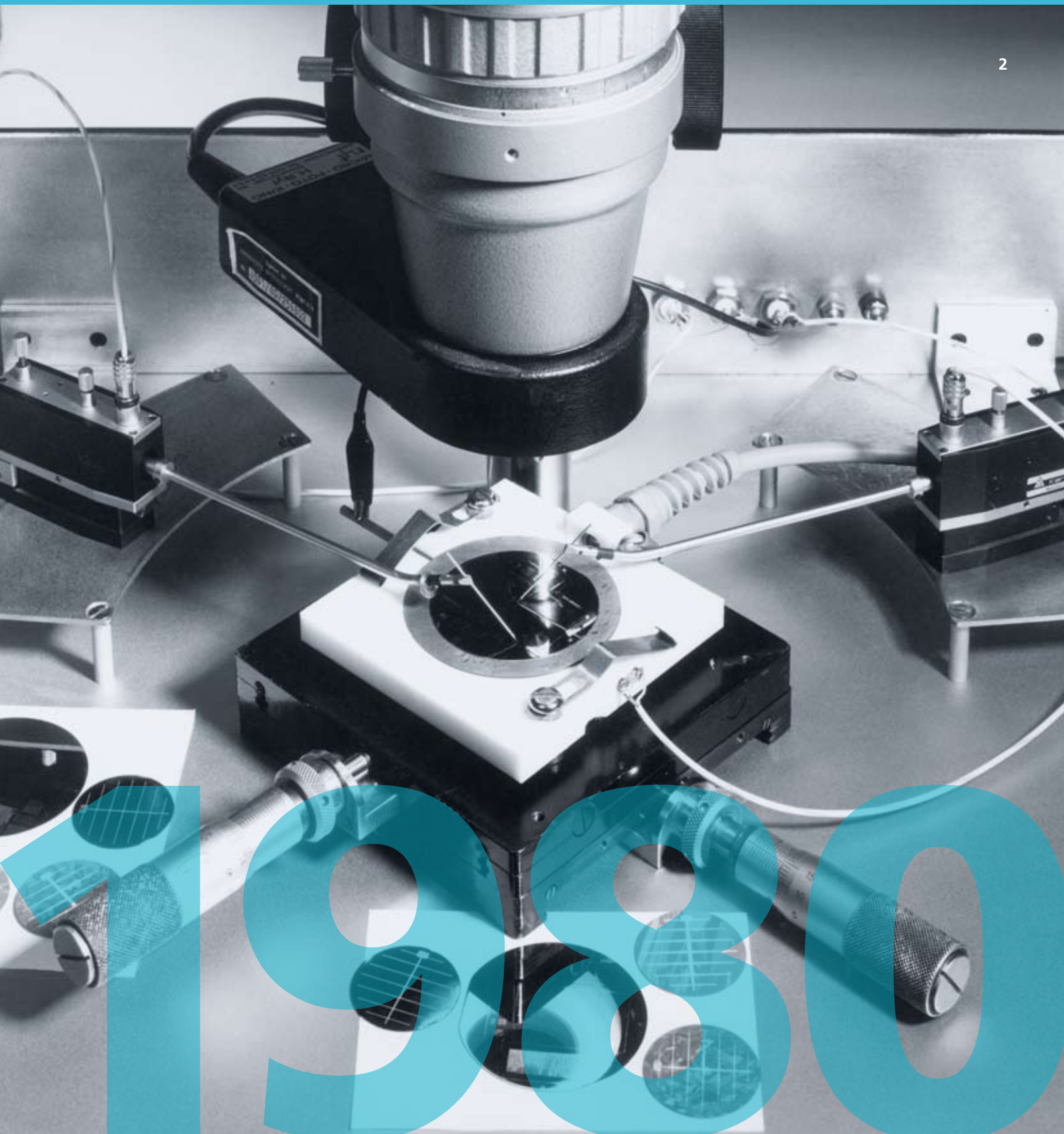
Growth and consolidation

1983

i The first German solar power station went into operation on the island of Pellworm.

Max Syrbe, hitherto director of the Fraunhofer Institute for Information and Data Processing IITB, took over the post of President of the Fraunhofer-Gesellschaft from Heinz Keller. His aim was to consolidate the rapid gain in size of the Fraunhofer-Gesellschaft over the previous ten years by following on with a phase of qualitative growth.

The Documentation Center for Water DZW in Düsseldorf was divested.



1980

{1984}

AFTER 35 YEARS, THE FRAUNHOFER-GESELLSCHAFT WORKFORCE HAD GROWN TO 3500. ITS 33 INSTITUTES GENERATED A BUSINESS VOLUME OF 360 MILLION MARKS.

1

1984

The Fraunhofer Institute for Laser Technology ILT was founded in Aachen to provide local industry with access to this forward-looking technology and take its development further.

"The laser's potential as an all-purpose industrial tool was not difficult to foresee, even though it had only just been developed. Fraunhofer's aim was to grasp the opportunities it presented at the earliest possible stage, while the market for applications was still emerging. Our preferred candidate to take over as the director of the Fraunhofer ILT was working at the time at the Darmstadt University of Technology in Hesse, but North Rhine-Westphalia had more concrete plans for this brilliant scientist, and was more willing to support his future career development. We defined the concept for the ILT in Aachen in a closed circle. When the plan went public, the agreements were already in place. These confidential negotiations in a network of reliable partners at governmental, *Länder* and university level ultimately led to our success."
Dr. Alexander Imbusch, director of the Research and Communications division through 2006 and "founding father" of many Fraunhofer Institutes.

The Fraunhofer Group for Microelectronics was founded, with the aim of avoiding overlapping projects and duplication of work by the institutes working in this field. Today, it is one of the world's four leading integrated research groups in the field of microelectronics.

In a published report, the Fraunhofer-Gesellschaft announced its intention to promote the formation of spin-offs by Fraunhofer employees, because this was seen as a particularly effective way of transferring know-how from the scientific community to private industry.

i The ABS antilock braking system was launched – an electronically controlled braking system for motor vehicles which prevents the wheels from locking during braking.

1985

In Erlangen, two working groups were formed in the field of microelectronics, which later became the Fraunhofer Institute for Integrated Circuits IIS, Applied Electronics Department, and the Fraunhofer Institute for Integrated Circuits IIS, Device Technology Department. The Institute for Aerosol Biology IAe in Schmallenberg was transformed into the Fraunhofer Institute for Environmental Chemistry and Ecotoxicology IUCT.

i The Deutsche Bundesbahn's high-speed inter-city train, the ICE, reached a maximum speed of 350 km/h during trials.

1986

In Darmstadt, the Working Group for Computer Graphics Research AGD was formed, which quickly grew into a fully-fledged institute, the Fraunhofer Institute for Computer Graphics Research IGD, founded in 1991.

i A level-7 nuclear event occurred at the Chernobyl nuclear power station in the Ukraine. The disaster caused widespread contamination with radioactive fission products, fuelling the international debate surrounding the safety and future of nuclear power.

1 *Laser cutting process.*
2 *The cochlea implant brought help to the hearing-impaired.*

{1989}

OVER THE LAST TEN YEARS, THE FRAUNHOFER-GESELLSCHAFT TRIPLED ITS KEY DATA: ALMOST 6400 EMPLOYEES IN 37 INSTITUTES NOW GENERATED A BUSINESS VOLUME OF NEARLY 700 MILLION MARKS A YEAR.

1987

i Hoechst AG started operation of a 60-cubic-meter fermentation plant in which genetically modified microorganisms produced human insulin. This marked the start of the industrial application phase of genetic engineering.

1988

The proportion of military research relative to the total Fraunhofer-Gesellschaft budget now lay at only 10 percent. This relative decline was largely due to strong growth in the civilian research fields and institutes.

.

i An important topic of debate in Western countries was the possibility of a global climate disaster as a result of the greenhouse effect.

1989

Contract research organizations in France, Italy, the United Kingdom, and the Netherlands joined forces with the Fraunhofer-Gesellschaft to found the European Association of Contract Research Organizations (EACRO), to represent their common interests in the European Union.

A cochlea implant developed at the Fraunhofer Institute for Microelectronic Circuits and Systems IMS restored rudimentary hearing to the totally deaf.

The Fraunhofer-Gesellschaft responded to the decline in the proportion of military research with a plan to convert certain areas of research and even entire institutes to civilian contract research. The greater part of this conversion plan was implemented over the next five years. One example of complete and successful conversion to contract research was the Fraunhofer Institute for Manufacturing Engineering and Applied Materials Research IFAM in Bremen.

i Tim Berners-Lee of the CERN nuclear research center in Geneva came up with his idea for a World Wide Web (WWW).

❝ Being able to utilize knowledge stored in a worldwide data archive is one of the pioneering services on the Web today. Interdisciplinary labs are conducting research on the 'semantic web', which will combine unrelated data into an interactive knowledge structure, creating virtual 'space to think'. ❞ *Prof. Monika Fleischmann is helping design the future of the Web with a research group and a media lab at the Fraunhofer IAIS. She describes herself as a "research artist".*

1990

The Fraunhofer Institute for Surface Engineering and Thin Films IST was set up in Braunschweig.

Fraunhofer president Max Syrbe announced the introduction of a suitable HR strategy. The aim was to promote a cooperative management style, ensure shared responsibility and provide development of opportunities for every member of staff. The core element was the so-called staff dialog, which focuses on the current situation, development opportunities and continuing education measures.

The micro membrane pump was developed at the Fraunhofer Institute for Solid State Technology IFT to reliably and continually transport small quantities of fluid. The invention was patented in Germany, the USA and Japan. Axel Richter received the 1991 Philip Morris research prize for this work, along with 120,000 marks in prize money.

1991

1991

The year of integration: Numerous research institutions in the new *Länder* were integrated in the Fraunhofer-Gesellschaft, initially on a short-term basis or as branch labs of existing institutes. The new units included branches of the Fraunhofer Institutes for

- Software and Systems Engineering ISST, Berlin
- Applied Polymer Research IAP, Teltow
- Microelectronic Circuits and Systems IMS, Dresden
- Electron Beam and Plasma Technology FEP, Dresden
- Material and Beam Technology IWS, Dresden
- Ceramic Technologies and Sintered Materials IKTS, Dresden
- Machine Tools and Forming Technology IWU, Chemnitz
- Factory Operation and Automation IFF, Magdeburg
- Applied Optics and Precision Engineering IOF, Jena
- Reliability and Microintegration IZM, Berlin

„We not only felt people treated us well but also felt their affection toward the East. That motivated us all – we showed our gratitude by also performing well under the new conditions: All the institutes in the east are now excellently placed. A key element in the successful integration was finding that those responsible quickly managed to agree on where we wanted to be and how to get there, and involved us early on. As such our staff gained a new perspective, managing to refocus on constructive work faster than elsewhere." *Dr. Udo Gerlach, until 2006 deputy director of the Fraunhofer IKTS in Dresden.*

In the old West German *Länder,* the Fraunhofer Institute for Biomedical Engineering IBMT was set up in St. Ingbert. The Working Group for High-Pressure Plasma Physics and Pulse Discharge Physics AGD in Erkrath was closed down.

Dr. Hermann Riedel from the Fraunhofer Institute for Mechanics of Materials IWM in Freiburg received the 1991 Gottfried Wilhelm Leibniz Prize for his research into high-temperature fraction mechanics.

1992

From vision to reality: The first energy-autonomous solar house, designed by the Fraunhofer Institute for Solar Energy Systems ISE, went into operation. Thanks to solar technology and excellent insulation, the house functioned without any external energy supply.

The Research Group for Hydroacoustics FHAK (previously FgHA) in Ottobrunn ceased its activities.

From this year onward, the Fraunhofer-Gesellschaft was consistently the most successful applicant for patents among all state-financed research institutions in Germany.

Professor Dr. Dieter Seitzer, director of the Fraunhofer Institute for Integrated Circuits IIS in Erlangen, was awarded the Karl Heinz Beckurts Prize, the highest award for applied research in Germany, for his work on efficient data reduction of digital signals.

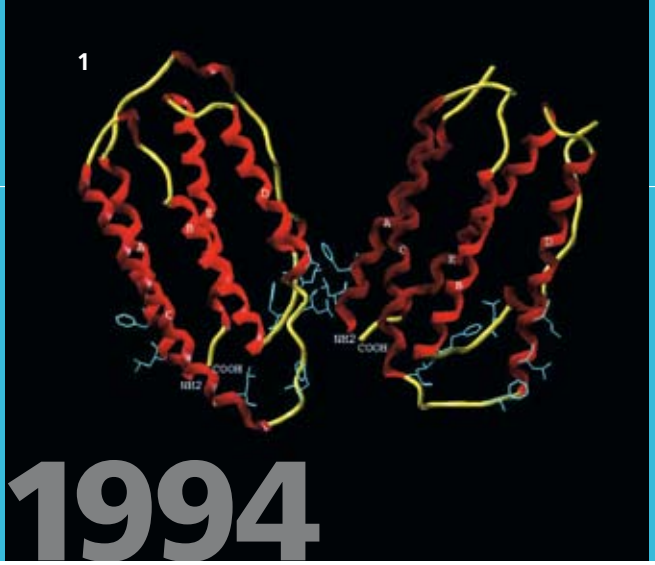
1 *Fraction mechanics as a research topic: Hermann Riedel received the Leibniz Prize.*

2 *The first energy-autonomous house in Germany.*

3 *Hans-Jürgen Warnecke, Fraunhofer president from 1993 to 2002.*

{1994}

45 YEARS AFTER ITS FOUNDATION, THE FRAUNHOFER-GESELLSCHAFT PROVIDED WORK FOR SOME 8000 EMPLOYEES. ITS 47 INSTITUTES GENERATED REVENUES OF AROUND 1.15 BILLION MARKS.



1994

New concepts for increasing globalization

1993

The total volume of funds flowing into the Fraunhofer-Gesellschaft exceeded one billion marks for the first time.

The "Guiding Principles 2000" were published, in which the Fraunhofer-Gesellschaft defined itself as a market and customer-oriented umbrella organization for applied research institutes, operating on a national and international basis. Criteria applying to institutes belonging to the Fraunhofer-Gesellschaft were tightened, making tough demands even for those research institutions already integrated into the organization, which called for a strict focus on activities relevant to industry.

Hans-Jürgen Warnecke, until now director of the very successful Stuttgart-based Fraunhofer Institute for Manufacturing Engineering and Automation IPA, took over the post of president from Max Syrbe.

i An engineering firm in Saxony marketed the first ecological, CFC-free refrigerator.

1994

As a response to the globalization of industry and science, the Fraunhofer-Gesellschaft stepped up its international activities. In August, Fraunhofer USA, Inc., was founded at Rhode Island to manage activities in the USA. Two Fraunhofer Centers started to operate under its auspices: the Fraunhofer Resource Center for Production Technology in Hartford, Connecticut, which one year later moved to Boston, Massachusetts, and the Fraunhofer Resource Center for Laser Technology in Ann Arbor, Michigan. All Fraunhofer Centers in the USA (known as Resource Centers in the initial years) are affiliated with related Fraunhofer Institutes in Germany.

1 *Model of the gamma interferon developed by Fraunhofer scientists.*

❝ When the Fraunhofer Center for Sustainable Energy Systems (CSE) was set up at MIT in 2008, we were able to build on excellent foundations because the Fraunhofer-Gesellschaft had already been operating in the USA for many years. Our presence enables us to gather information on local conditions quickly and efficiently, helping us to promote the use of renewable energies and, in turn, improving energy efficiency in the USA. ❞ *Prof. Dr. Eicke R. Weber joined Fraunhofer in 2006 from the University of Berkeley in the USA to become director of the Fraunhofer ISE. The solar expert is also the spokesman of the Fraunhofer Energy Alliance.*

After long discussions and changes to the original concept, the Fraunhofer Institute for Silicon Technology ISIT was set up in Itzehoe. It worked in close cooperation with Daimler-Benz subsidiary TEMIC (now Vishay).

Gamma interferon was produced using gene technology at the Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB. It is more effective than the interferon that occurs naturally in the human body.

1995

A new instrument designed to promote know-how transfer was introduced. Special laboratories attached to specific institutes, known as Fraunhofer Applications Centers, were set up with the aim of intensifying contacts between research and industry. This year saw the establishment of Fraunhofer Applications Centers for

- Waste Disposal and Transport Logistics (AEV) in Cottbus (new name from 1998, Logistics Systems Planning and Information Systems [ALI])
- Transport Logistics and Communication Systems (AVK) in Nürnberg
- Systems Technology (AST) in Ilmenau
- Processing Machinery and Packaging Technology (AVV) in Dresden
- Powder Metallurgy in Clausthal

2

1997

In November, the Federal Supreme Court ruled that contract research was a taxable commercial activity. It would take two years before an amendment to the tax law helped ensure that cooperation with the Fraunhofer-Gesellschaft remained a very compelling proposition for industry.

The Fraunhofer Working Group for Toxicology and Environmental Hygiene ATU was set up in Hamburg.

Fraunhofer launched the PROFIL program which allowed the Fraunhofer-Gesellschaft and its institutes to employ institutional funding for activities abroad.

A corporate design was introduced to standardize and improve the image of the Fraunhofer-Gesellschaft vis-à-vis its external publics while also promoting cohesion internally.

1996

The Fraunhofer Institute for Experimental Software Engineering IESE was founded in Kaiserslautern.

It was particularly at the international level that the Fraunhofer-Gesellschaft expanded its activities and presence this year: In the USA, the Fraunhofer Resource Center Delaware and the Fraunhofer Technology Center in Hialeah were added to the list of centers. Other outposts were established in Asia, with Representative Offices in Malaysia, Singapore, China and Indonesia that were initially supported in part by individual Fraunhofer Institutes. The aim was to create and maintain contacts in economic regions of present and future importance. The International Business Development department was set up in the central administration.

2 *World chess champion Garry Kasparov played against the "Deep Blue" computer.*

"Knowledge of foreign business cultures is an important basic cornerstone for designing new strategies. The idea that you could make money faster in Asia than in Europe was flawed since business is conducted on the basis of trust. Asia requires ongoing commitment. The Fraunhofer-Gesellschaft is endeavoring to live up to these expectations by setting up Representative Offices."
Dr. Dieter Fuchs set up the International Business Development department between 1996 and 2006.

The Fraunhofer Applications Center for Powder Metallurgy in Clausthal was closed down.

The 1996 Philip Morris research prize was awarded to Dr. Rainer Hintsche of the Berlin working group of the Fraunhofer Institute for Silicon Technology ISIT for the development of a fully-fledged mobile miniature laboratory.

1997

Six Fraunhofer Institutes joined forces to create the Fraunhofer Group for Materials and Components. The Fraunhofer Group for Production was set up in the same year.

The Fraunhofer Applications Center for Logistics-Oriented Business Administration (ALB) was set up in Paderborn.

To effectively close the gap between research institutes and industry, innovation centers were set up as an experimental model. In this way, the Fraunhofer-Gesellschaft expanded its field of business to include the production of prototypes for commercial use and short-run manufacturing. The innovation centers were organized on the same principles as private industry, in line with the recommendations formulated by the federal government in its "Guidelines for the strategic orientation of the German research environment" published in 1996.

{1999}

ON THE 50TH ANNIVERSARY OF ITS FOUNDATION, 9300 EMPLOYEES WERE WORKING IN 47 INSTITUTES, GENERATING A BUSINESS VOLUME CLOSE TO 1.4 BILLION MARKS FOR THE FRAUNHOFER-GESELLSCHAFT.

The proportion of military research in the total budget of the Fraunhofer-Gesellschaft meanwhile dropped to five percent as a result of the steady expansion of contract research business.

i For the first time, a reigning world chess champion, Garry Kasparov, lost against a chess computer, dubbed "Deep Blue" by its inventors.

1998

The Fraunhofer Institute for Environmental, Safety and Energy Technology UMSICHT, based at Oberhausen, was integrated into the Fraunhofer-Gesellschaft. This helped strengthen the organization's expertise in the fields of process engineering and environmental engineering.

The Fraunhofer Institute for Transport and Infrastructure Systems IVI was set up in Dresden.

The Fraunhofer Center for Experimental Software Engineering (CESE) was set up in College Park, Maryland, as a subsidiary of the Fraunhofer Institute for Experimental Software Engineering IESE.

A commercial breakthrough came courtesy of the audio-encoding techniques developed by Fraunhofer IIS. MPEG-2 Layer 3 (mp3), the most successful, was to be employed by three satellites transmitting digital radio broadcasts to the southern hemisphere from 1999 onward. The same technique became the de-facto worldwide standard for music transmission on the Internet in the course of 1998.

Four institutes pooled their expertise to create the Fraunhofer Group for Surface Technology and Photonics, in a bid to present a common approach to the market. The members were the Fraunhofer Institutes for

- Surface Engineering and Thin Films IST, Braunschweig
- Material and Beam Technology IWS, Dresden
- Electron Beam and Plasma Technology FEP, Dresden
- Laser Technology ILT, Aachen

1999

The Fraunhofer researchers Michael Schanz, Christian Nitta and Thomas Eckart received the 1999 Philip Morris Research Prize for developing a CMOS camera with an unrivalled dynamic brightness range.

The Fraunhofer Institute for Solid State Technology IFT in Munich was restructured, with parts being transferred to the Fraunhofer Institute for Communication Systems ESK and to the new Munich branch of the Fraunhofer Institute for Reliability and Microintegration IZM.

The decision was taken to integrate GMD – Forschungszentrum Informationstechnik GmbH into the Fraunhofer-Gesellschaft. The eight new institutes from GMD were grouped together with six Fraunhofer Institutes working in relevant fields to form the new Information and Communication Technology Group, which represented Europe's largest ICT research alliance with 14 institutes and 2500 staff.

To mark the 50th anniversary of the Fraunhofer-Gesellschaft, the Bavarian government instituted the Hugo Geiger Prize, named after former Bavarian secretary of state Hugo Geiger, patron of the inaugural assembly of the Fraunhofer-Gesellschaft on March 26, 1949. The Hugo Geiger Prize is awarded for outstanding, application-oriented doctoral theses or dissertations in the field of life sciences based on work directly related to a Fraunhofer Institute.

2001

Expansion and adaptation of the areas of business and research sectors

2000

In connection with the decision to integrate GMD, the Fraunhofer Executive Board was expanded to include four members:
Prof. Dr. Hans-Jürgen Warnecke (President)
Dr. Dirk-Meints Polter
Prof. Dr. Dennis Tsichritzis
Dr. Hans-Ulrich Wiese

The Fraunhofer-Gesellschaft opened a liaison office in Brussels reflecting its increasing orientation as a research organization active at European level. The aim was to provide the institutes with stronger support when competing for European research funding.

The Stifterverband Science Prize was awarded for the first time. This prize is awarded for scientific excellence in applied research projects conducted by Fraunhofer Institutes in collaboration with industry and/or other research organizations.

Karlheinz Brandenburg, Bernhard Grill and Harald Popp were awarded the German Future Prize 2000 for their research leading to the mp3 compression of audio signals in hi-fi quality for the Internet and radio.

2001

Fraunhofer entered a new area of business in training and development, with the aim of providing wider public access to research and the results of research work.

The development and expansion of the Molecular Biology Department at the Fraunhofer Institute for Environmental Chemistry and Ecotoxicology IUCT was so successful that the name of the IUCT was changed to Fraunhofer Institute for Molecular Biology and Applied Ecology IME.

The Fraunhofer Center for Molecular Biotechnology (CMB) was established in Newark, USA. Within just a few years it advanced to become the most successful branch of the Fraunhofer-Gesellschaft in America.

The Institute for Industrial Mathematics ITWM, established in 1995, was integrated in the Fraunhofer-Gesellschaft, thereby adding applied mathematics to the organization's research portfolio.

In Europe, the Fraunhofer-Gesellschaft took a step in a new direction. On the initiative of the Fraunhofer ITWM and in cooperation with Chalmers University in Sweden, the joint Fraunhofer-Chalmers Research Centre for Industrial Mathematics (FCC) was established in Gothenburg. It was the Fraunhofer-Gesellschaft's first collaborative venture in Europe in the form of an institution.

The integration of GMD – Forschungszentrum Informationstechnik GmbH was completed. As part of this process, the existing GMD office in Tokyo was expanded and re-designated as a Fraunhofer Representative Office. The high-technology country Japan had become an enormously important market for the Fraunhofer Institutes.

PAGES 26 I 27

1 *Fraunhofer Institute for Environmental, Safety and Energy Technology UMSICHT.*
2 *Tobacco plants produce medication.*

PAGES 28 I 29

1 *Presentation of the German Future Prize to the inventors of mp3.*
2 *The Fraunhofer Institute for Atmospheric Environmental Research IFU.*
3 *The new Fraunhofer-Gesellschaft headquarters in Munich.*

"The merger of the Society for Mathematics and Data Processing GMD with the Fraunhofer-Gesellschaft in 2001 created the biggest association of institutes for application-related IT research in Europe. Since then many of the institutes have undergone considerable change and have been able to position themselves successfully with innovative IT solutions. A good example is the Fraunhofer SIT, which by systematically sharpening its profile has acquired an internationally leading position in IT security."

Prof. Dr. Claudia Eckert is one of the few women to have chosen to study technical and scientific applications of mathematics. In 2001 she was appointed director of the Fraunhofer SIT and is currently expanding the institute.

Four Fraunhofer institutes joined together to create the Fraunhofer Group for Life Sciences.

i The terrorist attacks on the World Trade Center in New York on September 11 changed the international political situation. The subject of security acquired new importance for the general public and on the political agenda, and therefore also in the field of applied research.

2002

The Berlin-based Heinrich-Hertz-Institut was transferred from the Leibniz Association of German Research Institutes to the Fraunhofer-Gesellschaft as the Fraunhofer Institute for Telecommunications, Heinrich-Hertz-Institut, HHI, strengthening the Fraunhofer Group for Microelectronics.

The Fraunhofer Institute for Atmospheric Environmental Research IFU became part of the Karlsruhe Research Center and thus came under the umbrella of the Helmholtz Association of German Research Centers, where it found a suitable home with a mode of financing appropriate to the area of research.

After intensive debate, the Fraunhofer-Gesellschaft adopted a new set of guiding principles comprising a mission statement and the values and principle objectives derived from it. The values and principle objectives are upheld by all staff of the Fraunhofer-Gesellschaft in their everyday activities and are thus the concrete expression of the organization's corporate culture.

Prof. Dr. Hans-Jörg Bullinger, director of the Fraunhofer Institute for Industrial Engineering IAO, took over as President of the Fraunhofer-Gesellschaft from Prof. Dr. Hans-Jürgen Warnecke. Dr. Alfred Gossner succeeded Dr. Hans-Ulrich Wiese as Senior Vice President Finance.

Given the changed security situation after the terrorist attacks on September 11, 2001, five Fraunhofer Institutes joined together to form the Fraunhofer Group for Defense and Security.

Prof. Dr. Karl Leo, who is now director of the Fraunhofer Institute for Photonic Microsystems IPMS, was awarded the Gottfried Wilhelm Leibniz Prize, Germany's most highly endowed research award, for his work on organic light-emitting diodes (OLEDs).

2003

The new Fraunhofer headquarters building was opened on Hansastrasse in Munich. Numerous companies as well as seven Fraunhofer Institutes were involved in the planning and construction of the innovative and communication-friendly building.

For the first time, Fraunhofer presented twelve subject areas that it had chosen as its lead innovations. The list comprises key areas of research for which significant future market potential has been identified and in which the Fraunhofer Institutes can expect to play a significant role.

2004

{2004}

55 YEARS AFTER THE ESTABLISHEMENT OF THE FRAUNHOFER-GESELLSCHAFT, 12,500 STAFF IN 58 INSTITUTES GENERATED A BUSINESS VOLUME EXCEEDING ONE BILLION EUROS.

2004

Dr. Rainer Hintsche of the Fraunhofer Institute for Silicon Technology ISIT, together with Dr. Walter Gumbrecht from Siemens AG Corporate Technology and Dr. Roland Thewes from Infineon AG, was awarded the German Future Prize 2004 for the development of the "laboratory on a chip".

The Fraunhofer-Gesellschaft became heavily involved in the "Partners for Innovation" initiative launched by German Chancellor Gerhard Schröder and in which he continued to take a personal interest.

With the establishment of the Fraunhofer Center for Nanoelectronic Technologies CNT in Dresden, Fraunhofer created the opportunity for closer cooperation with industry in the important R&D market for nanoelectronics.

The highly successful Working Group for Digital Media Technology at the Fraunhofer Institute for Integrated Circuits IIS became the Fraunhofer Institute for Digital Media Technology IDMT.

The Fraunhofer Project Group for Production Management and Logistics (PPL) was set up in Vienna.

1 *The winners of the German Future Prize 2004.*
2 *The Leibniz Prize was awarded to Andreas Tünnermann for the development of the color laser.*
3 *Presentation of the German Environmental Prize to Joachim Luther.*

2005

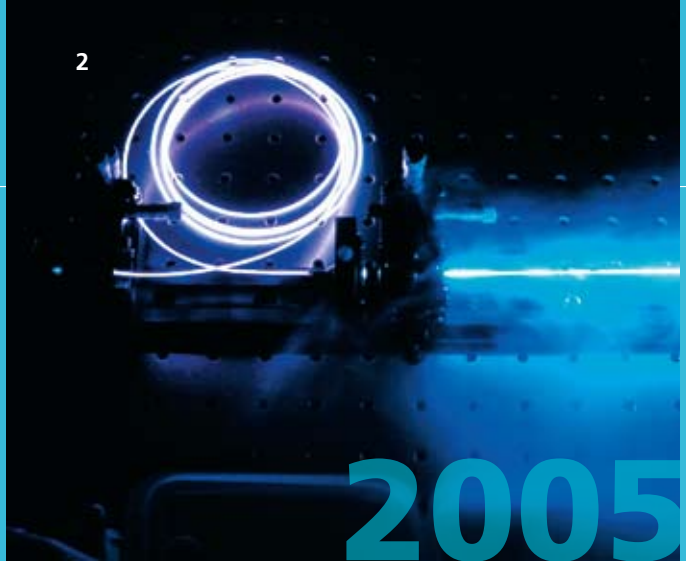
The lead innovations published in 2003 were reviewed on the basis of an evaluation of numerous foresight studies produced by other industrial countries and road maps drawn up by international companies. The result was a list of twelve areas of technology that Fraunhofer expected to lead to significant market-relevant innovations. These "Signposts to tomorrow's markets" were published in 2005.

In cooperation with a venture capital company, Fraunhofer set up a fund to finance innovative high-tech firms, with special emphasis on spin-offs from the Fraunhofer-Gesellschaft.

" At the beginning of 2009, four years after being spun off from the Fraunhofer Institute for Solar Energy Systems ISE, Concentrix now has nearly 80 employees. Highly qualified engineers and technicians in Germany produce our solar modules which are among the most highly efficient worldwide. " *Hans-Jörg Lerchenmüller, once a Fraunhofer staff member, is now CEO of Concentrix Solar GmbH. In 2007, the company was awarded the German Industry Innovation Prize.*

The Fraunhofer Institute for Cell Therapy and Immunology IZI was established at Biocity Leipzig. Its role is to develop specific problem solutions at the interface between the medical, biological and engineering sciences for partners in business and industry.

Russia's dynamic economic growth and the country's steadily increasing orientation to the West offered many new opportunities in the research sector. The Fraunhofer-Gesellschaft responded to this by opening a Representative Office in Moscow as a platform for Russian partners in industry and research.



By establishing the first innovation clusters, Fraunhofer pursued the objective of pooling the specialist expertise and organizational competence of the institutes in a new form of partnership between research institutes, universities and industry.

The Pilot Plant Center for Polymer Synthesis and Polymer Processing (PAZ) was established in Schkopau with the aim of strengthening research and development capacity in this central German region dominated by the chemicals industry.

The Fraunhofer Technology Academy was established with the aim of imparting innovative knowledge to specialists and managers from industry as well as strengthening contact with them.

Prof. Dr. Andreas Tünnermann of the Fraunhofer Institute for Applied Optics and Precision Engineering IOF was awarded the Gottfried Wilhelm Leibniz Prize 2005 for his pioneering work in the development of high-power fiber lasers.

For his work on the development and expansion of solar energy use, Prof. Dr. Joachim Luther, director of the Fraunhofer Institute for Solar Energy Systems ISE, received the prestigious German Environmental Award 2005 from the Deutsche Bundesstiftung Umwelt (DBU) foundation.

The prize for human-centered technology was awarded for the first time. It was endowed by former Executive Board members and institute directors of the Fraunhofer-Gesellschaft to honor outstanding scientific achievements by Fraunhofer employees which help people to remain active in daily life up to a very old age and improve the environment in which they live.

2006

Prof. Dr. Dennis Tsichritzis, Senior Vice President International Business Development, entered retirement. Prof. Dr. Ulrich Buller, former director of the Fraunhofer Institute for Applied Polymer Research IAP, was appointed Senior Vice President Research Planning.

Four new innovation clusters were established in 2006, taking the total to seven:

- Automotive Quality Saar AQS, Saarbrücken
- Digital Commercial Vehicle Technology DNT, Kaiserslautern
- Digital Production, Stuttgart
- Mechatronic Machine Systems, Chemnitz
- Nano for Production, Dresden
- Optical Technologies JOIN, Jena
- Personal Health, Region Erlangen, Nürnberg, Fürth

The two Fraunhofer Institutes for Media Communication IMK and for Autonomous Intelligence Systems AIS in Birlinghoven were merged to create the Fraunhofer Institute for Intelligent Analysis and Information Systems IAIS. The Fraunhofer Institute for Integrated Publication and Information Systems IPSI was dissolved; its promising and marketable research activities were transferred to other Fraunhofer Institutes.

The German government introduced the "High-tech strategy for Germany", which defined 17 areas of technology that were expected to provide a particularly strong impetus for the economy. Fraunhofer supported this initiative and outlined 14 of the topics that tied in with key research areas at the Fraunhofer Institutes.

German research minister Dr. Annette Schavan set up a new advisory council, the "Research union economy – science". Fraunhofer president Prof. Dr. Hans-Jörg Bullinger and Stifterverband president Dr. Arend Oetker were appointed as its joint chairmen.

2006

The opening of the Fraunhofer Center for Central and Eastern Europe MOEZ in Leipzig presented the opportunity to intensify cooperation between companies and research establishments in eastern Europe.

2007

Dr. Dirk-Meints Polter, Senior Vice President Human Resources and Legal Affairs, entered retirement.

The Fraunhofer Center for Silicon Photovoltaics CSP was established in Halle. Run by the Fraunhofer Institutes for Mechanics of Materials IWM and for Solar Energy Systems ISE, it provides research-technology support to photovoltaics companies in Saxony-Anhalt.

The Fraunhofer Patent Office for German Research PST was dissolved for reasons of tax law.

With the introduction of the "Fraunhofer Attract" program Fraunhofer pursued the goal of encouraging excellent scientists with innovative ideas to join the organization. 40 "Attract research groups" were advertised for the period 2007 to 2009, with 2.5 million euros earmarked for each.

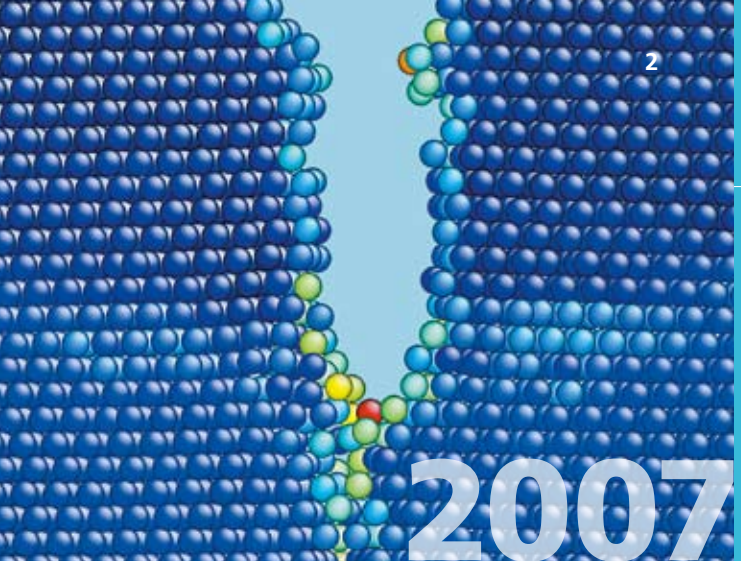
"The Attract funding program has enabled me to build my first research team at the Fraunhofer IPMS. We develop active lenses that change their focal length as a function of an applied electrical voltage. Here I have found the optimum conditions to apply the experience I gained as a materials scientist working in basic research at Brandenburg University of Technology in Cottbus." *Dr. Florenta Adriana Costache, who was encouraged to join Fraunhofer by the Attract program and who since the beginning of 2008 has headed a working group at the Fraunhofer IPMS.*

In a statement of opinion, the German Science Council recommended that the three institutes of the Forschungsgesellschaft für Angewandte Naturwissenschaften e.V. (FGAN) engaged in security technology research should be integrated in the Fraunhofer-Gesellschaft.

The Deutsche Forschungsgemeinschaft (DFG) awarded the Leibniz Prize 2007 to Prof. Dr. Peter Gumbsch, director of the Fraunhofer Institute for Mechanics of Materials IWM, for his research on the deformation and fracture of materials. The prize worth 2.5 million euros will be used to finance research on the origin of material defects and on friction and wear processes.

Dr. Andreas Bräuer of the Fraunhofer Institute for Applied Optics and Precision Engineering IOF together with Dr. Klaus Streubel and Dr. Stefan Illek of Osram Opto Semiconductors GmbH received the German Future Prize for the development of a high-performance light-emitting diode with the potential to revolutionize many areas of lighting technology.

The internationalization of the Fraunhofer-Gesellschaft entered a new phase: In Austria, the Fraunhofer IGD's project group started its work at Graz University of Technology. Fraunhofer USA opened a branch on the American west coast. Fraunhofer USA Digital Media Technologies (DMT) in San Jose offered a new platform for customers from the IT sector, in particular for the key enterprises in nearby Silicon Valley. In South Korea, Fraunhofer expanded the network of representative offices in Asia by opening an office in Seoul. The MENA countries had become interesting too. Fraunhofer established a local contact point in Dubai by opening the Fraunhofer Representative Office Middle East in Dubai.



2008

The President of Munich University, Prof. Dr. Marion Schick, was appointed Senior Vice President Human Resources and Legal Affairs on October 1, 2008, succeeding Dr. Dirk-Meints Polter.

The Chemnitz branch of the Fraunhofer Institute for Reliability and Microintegration IZM gained separate organizational status as the Fraunhofer Research Institution for Electronic Nano Systems ENAS. The same organizational change was made to create the Fraunhofer Research Institution for Marine Biotechnology EMB in Lübeck, which hitherto had been a department of the Fraunhofer Institute for Biomedical Engineering IBMT. The Fraunhofer Technology Development Group TEG was dissolved and its capacities integrated in the Institute Center Stuttgart.

Fraunhofer defined six thematic areas in which future technologies and products were most likely to have a significant beneficial impact on people's lives. In an intensive discourse focusing on these basic themes, research fields were identified which could contribute quickly and effectively to meeting current challenges such as climate change, depletion of natural resources and preventive healthcare. With these twelve "Frontline themes", the Fraunhofer-Gesellschaft demonstrated its active role in safeguarding the future of Location Germany.

Prof. Dr. Dr. Holger Boche of the Fraunhofer Institute for Telecommunications, Heinrich-Hertz-Institut, HHI received the Gottfried Wilhelm Leibniz Prize 2008 for his work on the mobile communication networks of the future. He chose to invest the 2.5-million-euro endowment in further research on advanced data transmission techniques in mobile communication.

Capitalized with 95 million euros from mp3 license-fee revenue, the Fraunhofer-Zukunftsstiftung (Fraunhofer Future Foundation) was established for the purpose of funding pre-competitive research in targeted fields of technology where patent clusters can be usefully developed.

The Fraunhofer Forum was established in Berlin as the Fraunhofer-Gesellschaft's communication platform in the German capital.

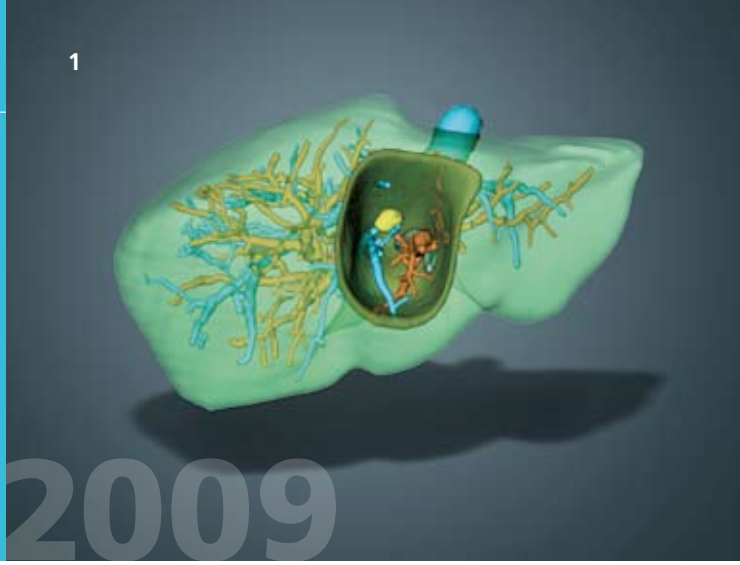
Six new innovation clusters took up their activities in 2008:

- Adaptronic Systems RheMa, Darmstadt
- Future Security BW, Freiburg
- Integrative Production Engineering for Energy-Efficient Turbomachines TurPro, Aachen
- Multifunctional Materials and Technologies MultiMaT, Bremen
- Polymer Technology, Halle, Leipzig
- Technologies for Hybrid Lightweight Construction KITe hyLITE, Karlsruhe
- Virtual Development, Engineering and Training VIDET, Magdeburg

1 *Establishment of the Production innovation cluster.*
2 *Peter Gumbsch received the Leibniz Prize for his research on deformation and fracture of materials.*
3 *Holger Boche was awarded the Leibniz Prize for his research on mobile communication networks of the future.*

{2009}

THE FRAUNHOFER-GESELLSCHAFT CELEBRATED ITS 60TH ANNIVERSARY. 15,000 EMPLOYEES IN 57 INSTITUTES GENERATED A BUSINESS VOLUME OF 1.4 BILLION EUROS. THE SUBSIDIARY COMPANY FRAUNHOFER USA, INC., HAD A BUDGET OF MORE THAN 30 MILLION EUROS ON ITS 15TH ANNIVERSARY. CLOSE ON 200 PEOPLE ARE EMPLOYED IN THE 7 CENTERS OF FRAUNHOFER USA.



For the first time subsidiary companies were established in Europe. In Austria, Fraunhofer Austria Research GmbH was formed as the umbrella organization for existing and future project groups and branches of the Fraunhofer-Gesellschaft.

In Portugal, Associação Fraunhofer Portugal Research was formed to run the new Fraunhofer Center for Assistive Information and Communication Solutions (AICOS) in Porto.

The network of Fraunhofer USA was further expanded with the addition of the Fraunhofer Center for Sustainable Energy Systems (CSE). The direct cooperation partner on site, the Massachusetts Institute of Technology (MIT), is one of the most prestigious research organizations worldwide.

2009

MeVis Research GmbH with its research expertise in medical technology was integrated in the Fraunhofer-Gesellschaft as the new Bremen-based Fraunhofer Institute for Medical Image Computing MEVIS.

The Fraunhofer Institute for Wind Energy and Energy System Technology IWES was established in Bremerhaven. It will continue the work of the Fraunhofer Center for Wind Energy and Maritime Technologies CWMT created in 2006.

As an internationally operating contract research organization, Fraunhofer continuously adapts to developments in the research sector and to changes in the business world. Social macrotrends are interpreted, innovative research scenarios integrated and relevant markets identified. The core capabilities and business activities have to respond flexibly to change, but also require reliable medium-term perspectives as it takes time to develop expertise in the R&D sector.

The Fraunhofer-Gesellschaft has been consistently widening its European and international orientation for several years on a sustainable basis. The Executive Board confirmed the presented European strategies in 2002 and 2007 and numerous strategically important measures were implemented as a result.

The international development of the organization is impressively underlined by substantial growth in worldwide bilateral contract research activities and EU-funded joint projects, a subsidiary company operating successfully in the world's biggest and most important research market, the establishment of further subsidiaries, branches and representative offices, and the initiation of numerous collaborative ventures with prestigious partners. This position will not only be maintained but will be steadily strengthened.

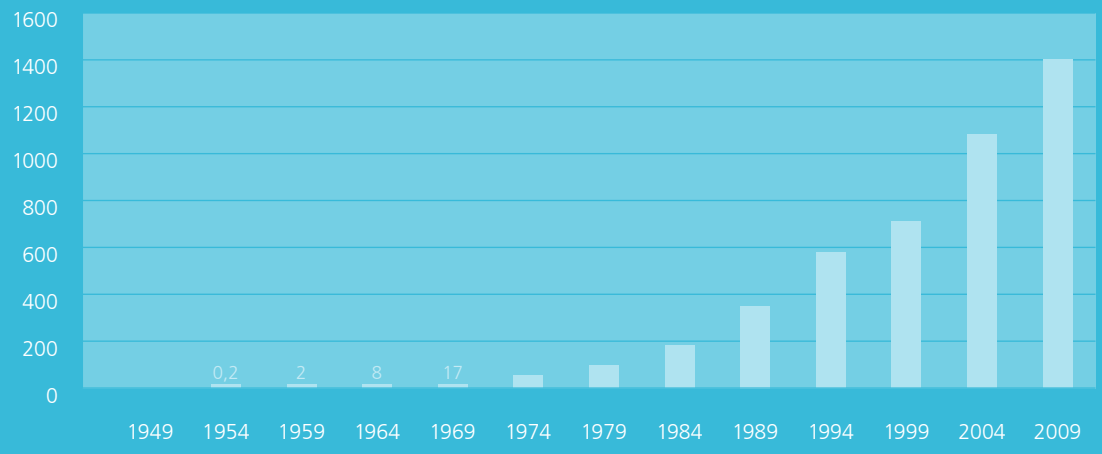
Top-level discussions are held at regular intervals to identify significant issues to which particular importance will be attached for a period of around three years. Alongside the initiatives at institute and alliance level, the Fraunhofer frontline themes form the basis for an additional alliance-overarching process. The aim is to concentrate resources and capabilities on selected key areas of research of high relevance to the market and society in general, and develop them through to market readiness within a time horizon of three to five years by exploiting synergy effects.

Fraunhofer is in a good position to fulfill its role as an innovation engine for business and industry in Germany and Europe.

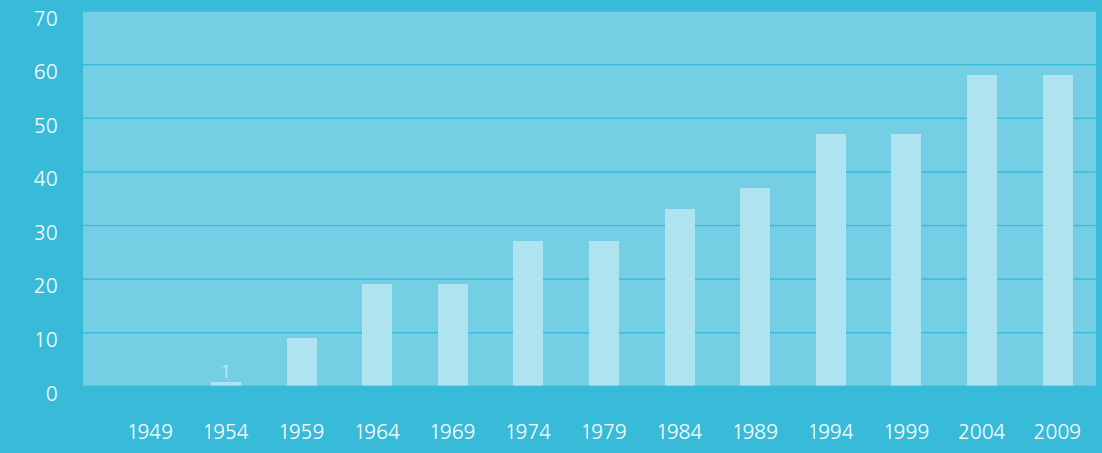
1 *The new Fraunhofer Institute for Medical Image Computing MEVIS.*

GROWTH OF THE FRAUNHOFER-GESELLSCHAFT

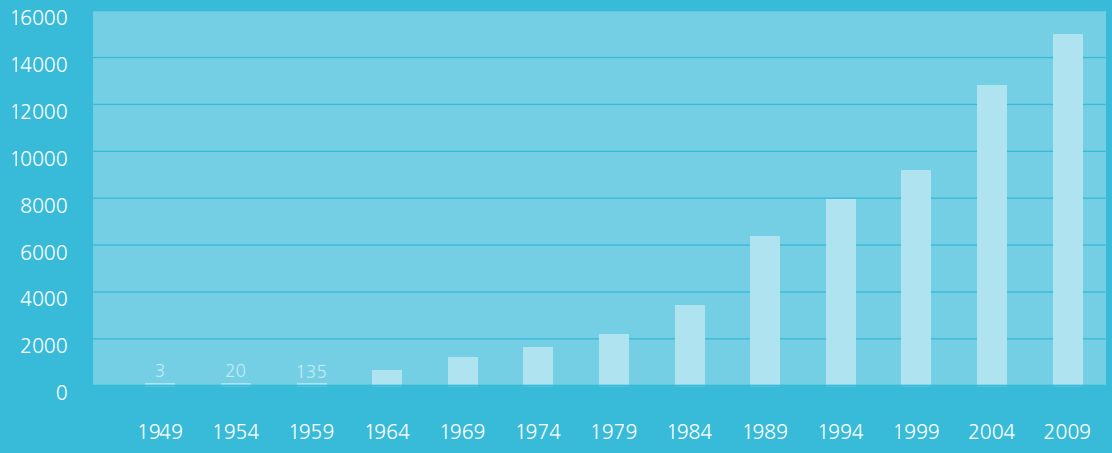
Budget (€ million)



Institutes



Employees



JOSEPH VON FRAUNHOFER: RESEARCHER, INVENTOR, ENTREPRENEUR

A scientist of world renown

Joseph von Fraunhofer counts among the most important scientists in the history of technology. He was a pioneer in optics, a technical field in which his work has had a lasting influence. Any student grappling with physics and optics today will encounter the "Fraunhofer absorption lines" in the solar spectrum and the phenomenon of "Fraunhofer diffraction".

Fraunhofer achieved worldwide fame as a scientist, even though he only had a humble apprenticeship as a glazier, acquired his scientific knowledge and skills on his own, and died at the young age of 39.

Systematic thinking leads to success as an entrepreneur

Fraunhofer's achievements were not limited to scientific research. He also set new standards as an entrepreneur and inventor. The improvements he made to glass manufacturing processes and the production of optical instruments paved the way to his scientific discoveries and additionally brought him economic rewards. During the period in which he managed the glassworks in Benediktbeuern, he transformed it into a modern manufacture and a profitable business.

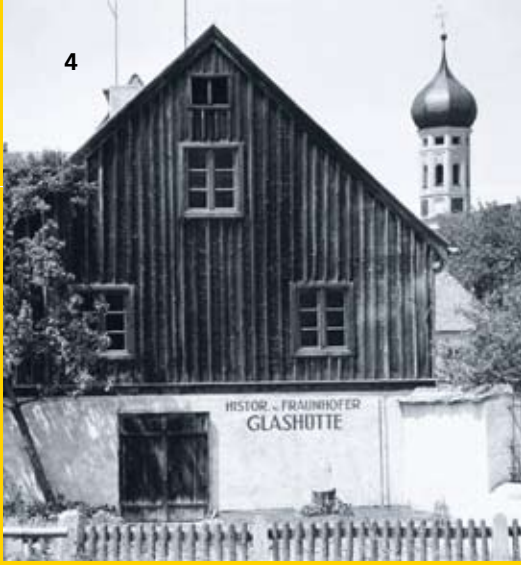
One major reason for his success was his application of new methods in the development and manufacturing of commercial goods. Fraunhofer systematically analyzed every aspect of materials, manufacturing and the product and then developed new materials, processes and testing methods. This allowed him to maintain control over quality, production output and costs at all times.

Applied research was Fraunhofer's guiding principle. That is why the Fraunhofer-Gesellschaft bears his name.

The life of a self-taught genius

Joseph Fraunhofer was born March 6, 1787, in Straubing, Lower Bavaria, the eleventh child of Franz Xaver and Anna Maria Fraunhofer. From 1799 to 1804, he trained as an apprentice to the mirror-maker and ornamental glass grinder Philipp Anton Weichselberger in Munich, for whom he later worked as a journeyman.

In 1806, Fraunhofer was engaged in the optical department of the mathematical-mechanical institute of Reichenbach, Liebherr and Utzschneider, which also owned the glassworks at Benediktbeuern. Within a few years, he was put in charge first of glass processing operations, then of the glassworks and finally of the entire Mathematical-Mechanical Institute.



Fraunhofer's career as a scientist ultimately gave him the status of a salaried professor and curator of the Physics Cabinet of the Bavarian Academy of Sciences. In 1824, King Max Joseph I awarded him a knighthood of the "Civil Order of Merit of the Bavarian Crown", which henceforth entitled him to use the name "von Fraunhofer" as a sign of nobility. Fraunhofer died in Munich on June 7, 1826.

A museum illustrating his work

Joseph von Fraunhofer spent the most important period of his professional life in Benediktbeuern. It was the site of the glassworks where his scientific methods transformed production, which attained a quality unseen until then. Fraunhofer was able to solve the problems encountered in manufacturing optical instruments at the time, because he understood how to connect three things: Research, the implementation of the research findings in applications and the marketing of finished products.

Fraunhofer applied these principles most obviously in his refractors, large astronomical telescopes whose lenses represented an outstanding technical achievement for their time. One of these instruments is displayed in the foyer of the Fraunhofer-Gesellschaft headquarters in Munich. It was manufactured in around 1820 and has an aperture of 163 mm and a focal length of 2500 mm.

The glassworks in Benediktbeuern has been restored and turned into a small museum. It houses not only the original glassmaking kilns, but also many exhibits including samples of glass, tools of the glass-working trade, various components and optical instruments.

1 *Joseph von Fraunhofer demonstrates the spectrometer to Joseph von Utzschneider, Georg von Reichenbach and Georg Merz.*
2 *Joseph von Fraunhofer, researcher, inventor and entrepreneur.*
3 *Fraunhofer built microscopes with excellent optical properties.*
4 *The historic glassworks in Benediktbeuern.*


1978

JOSEPH VON FRAUNHOFER PRIZE: THE WINNERS AND THEIR WORK

The Joseph von Fraunhofer Prize was awarded for the first time by the Fraunhofer-Gesellschaft in 1978, at its annual general assembly. It has been awarded every year since then in recognition of outstanding scientific work leading to the solution of application-oriented problems.

1978

Dr. Günther Baur, Waldemar Greubel, IAF: Fluorescence-activated display

Ulrich Lübbert, IITB: Automation of root welding

1979

Dr. Wolfgang Mohr, Wilhelm Repplinger, IZFP, and Dr. Wolfram Wettling, Dr. Wolfram Jantz, Dr. Roland Diehl, IAF: Ultrasound excitation and ultrasound measurement

1980/1981

Dr. Ulrich Kaufmann, IAF: Analysis of defects in III-V semiconductors GaP, GaAs and InP

Christoph Eisenbarth, Erich Enderle, Prof. Dr. Jörgen Peter Foith, Dr. Heribert Geißelmann, Hermann Ringshauser, Dr. Georg Zimmermann, IITB: The MODSYS modular system of image processing sensors for visual examination, machine and handling device activation and process control and regulation

Werner Patzelt, IITB: Position control of industrial robots with decoupling through the inverse system

Otto Alfred Barbian, Rudolf Karl Neumann, IZFP: Automated ultrasound testing methods and systems

1982

Dr. Dieter Hochrainer, Dr. Hans Peter König, Günter Oberdörster, Dr. Shinji Takenaka, ITA: Carcinogenicity of cadmium aerosols

Eckhard Bergmann, Dr. Alfred Dumbs, IPM: Elaboration and application of the D-field principle in non-contact measurement systems

1983

Dr. Heinz Lowak, LBF: Studies on the influence of component size, load sequence and load level on the increase in dynamic strength due to mechanically generated internal compressive stress

Iris Altpeter, Bernhard Reimringer, Dr. Werner Theiner, IZFP: Non-destructive analysis of the microstructure and internal stresses in hardened steels and heat-treated subsurface layers

1984

Dieter Boley, IPA: Interactive programming of industrial robots

August Potthast, IPK: Graphic-dynamic simulation of NC programs

1985

Dr. Helmut Ennen, William Haydl, IAF: Luminescence of rare earths in semiconductors

Dr. Franz Quante, Ahmet Topkaya, IITB: Instruments for the diagnosis and therapy control of periodontitis (periodontopathy) in dental practice (periotest)

1 *Günter Baur, one of the first-ever winners of the Joseph von Fraunhofer Prize, receiving his award from the Fraunhofer president at the time, Heinz Keller.*

1986

Michael Göhner, Gerd Schlaich, IPA: Fully automated cable assembly using robots

Gottfried Bonn, Rudi Grimm, Ingolf Hertlin, Joachim Tatje, IITB: System architecture and program design of very large operator-process control systems

Gerhard Fischer, Dr. Vatroslav Grubisic, LBF: Experimental setup for investigating the structural durability of vehicle wheels, hubs and bearings under close-to-real-life conditions

Dr. Horst-Lothar Fiedler, IMS: Manufacture of a monolithic VLSI component for ISDN interfaces

Wolfgang Müller, Günter Schäfer, Dr. Volker Schmitz, IZFP: Methods and equipment for the ultrasound imaging of materials defects

Prof. Dr. Wolfram Wettling, Dr. Johannes Windscheif, IAF: Non-destructive testing of GaAs wafers

1987

Dr. Rudolf Fahrig, ITA: Hypothesis on the genetic mechanism in tumor promotion and co-carcinogenesis and its application as a short-duration test

1 *The winners of the Joseph von Fraunhofer Prize are traditionally seated in the front row at the annual general assembly.*
2 *Fraunhofer president Max Syrbe handing over the awards.*
3 *Scientists from the Fraunhofer IIS received the Joseph von Fraunhofer Prize for their work on data reduction in audio signals.*

Dr. Frank Michael Hutter, Dr. Alfred Kaiser, ISC: Removal of arsenic from grinding shop wastewater in the glass industry

Ulrike Brosamer, Bernhard Urich, Dr. Bert Voß, IWM: Computer-controlled test system to determine material properties in the ductile fracture area by the partial load relief method

Dr. Eckhard Beyer, Arnold Gillner, Dr. Reinhart Poprawe, Dr. Falk Rühl, Dr. Konrad Wissenbach, ILT: Laser system for domain refinement in grain-oriented electric steel sheets

Dr. Wilhelm Dangelmaier, Ralf Michael Fuchs, Günther Hachtel, Hermann Kühnle, IPA: Graphic-supported production planning and control system

1988

Carlo Benecke, Rudolf Bachers, Bernd Becker, Michael Augustin, IPA: Simulation system for material transportation and warehousing processes

Dr. Eckhard Beyer, Reinhard Kramer, Dr. Peter Loosen, Frank Treppe, Heinrich Willerscheid, IPT: Methods and apparatus for laser beam diagnosis

Hans-Peter Kugler, Dr. Norbert Eisenreich, Adam Geißler, Claus Fabry, ICT: Optical method for dynamic measurement of Poisson's ratio of materials

Wolfram Budde, IMS: CMOS circuit for automatic telephone selector switch

Ingolf Münster, IMS: Integrated circuit for camera control

Dr. Friedrich Otto, IUCT: Flow cytometric determination of deviations and variability of the quantity of cellular DNA

Dr. Hariolf Grupp, Olav Hohmeyer, Dr. Ulrich Schmoch, ISI: Method for the calculation of technology indicators

1989

Prof. Dr. Cornelius Zetzsch, ITA: Aerosol smog chamber and scientific works on the photo-degradation of atmospheric trace elements and their reaction kinetics

Klaus Scherer, Michael Bollerott, Werner Brockherde, Gerhard Kellings, IMS: Microelectronic ear prostheses designed for high speech intelligibility

Dr. Wolfgang Gebhardt, Friedhelm Walte, IZFP: Single-head ultrasound testing method to detect fissures in thick-walled welded structures using mode conversion

Eckhardt Schneider, Rüdiger Herzer, IZFP: Automatic measurement system to determine mechanical stresses in building components using multi-mode ultrasound waves

1990

Bernd Volkwein, Volker Ziegler, IMS: Identification system for locking and tool-changing tasks with an auto-adaptive method for energy and data exchange

Dr. Armin Gemmler, Dr. Klaus Mertz, Thomas Bolch, Dr. Willi Keller, IPA: Environmentally compatible disposal of halogenated hydrocarbons

Dr. Dieter Siegele, Dr. Uwe Soltész, IWM: Shape and design optimization of dental implants

1991

Franz Cepl, Hans Hauer, Armin Deierling, IIS: Monolithically integrated single-sideband transceiver module for the implementation of a decentralized voice and signal transmission system

Dr. Helge-Björn Kuntze, Prof. Dr. Sebastian Engell, Robert Kerker, IITB: Model-based control and optimization of a glass-drawing process

Dr. Walter Döll, Dr. Günter Kleer, Dr. Peter Manns, IWM: Ductile forming of precision optical lenses

Michael Maisl, IZFP: High-resolution X-ray-computed tomography for materials testing

Dr. Werner Kördel, IUCT: Analysis and evaluation system to ascertain risk to groundwater from pesticides

Dr. Olav Hohmeyer, ISI: Method for analyzing and internalizing the social costs of electricity generation

1992

Michael Konstanzer, IAF: Methods and apparatus for the surgeless switching of grid transformers

Ernst Eberlein, Bernhard Grill, Jürgen Herre, IIS: Data-rate reduction of digitally coded audio signals for transmission and storage

Dr. Bertram Nickolay, IPK: Surface testing using knowledge-based image evaluation

Dr. Dong-Zhi Sun, Dr. Winfried Schmitt, IWM: Micromechanical models for component failure detection

Michael Pyra, Klaus Mehlkopp, Thomas Terwei, IPT: High-speed tool servo with piezoelectric actuator for ultra-precise turning of non-rotationally symmetric surface structures on non-ferrous metal mirrors

Dr. Dieter Fuchs, ISC: Use of glass sensors in environmental monitoring


1994

1993

Dr. Karl Heinz Bachem, Dr. Wilfried Plentschen, IAF: Development of a GaInP/GaAs hole barrier bipolar transistor, a new, low-cost microwave component for mobile telephony

Dr. Ulrich Schmoch, Dr. Knut Koschatzky, ISI: Company-oriented information service for regional patent information centers

Dr. Bernd Otto, Dr. Joachim Böhm, Dr. Otto Slodowski, ITA: New, recombinant interferon gamma with increased biological activity

Kai-Uwe Preißig, Dirk Petring, ILT: Laser process for the flexible, non-contact high-speed cutting of metal strip stock

Norbert Laudwein, Axel Brinkop, IITB: Knowledge-based design of stirring mechanisms

Dr. William H. Haydl, Michael Schlechtweg, IAF: Co-planar waveguides for microwave and millimeter-wave systems

1994

Dr. Friedrich G. Böbel, Dr. Norbert Bauer, Heino Möller, IIS: Pyrometric interferometry, a new film-thickness measurement technique for the in-situ monitoring of epitaxy processes

Dr. Herbert Wolter, ISC: Amalgam substitute based on novel ORMOCER® composite materials

Dr. Herbert Emmerich, IPA: Highly flexible, fully automatic wiring of technical systems using industrial robots

1995

Thomas Desel, Thomas Reichel, Stefan Rudischhauser, IIS: Multi-channel measuring sensor for medical device applications

Dr. Karl-Heinz Bachen, Joachim Wiegert, Kurt Winkler, IAF: MOVPE reactor for mass production of III/V semiconductor films

Thomas Fred Herkommer, Dr. Martin-Christoph Wanner, IPA: Development of highly flexible, mobile large manipulators such as those used in the cleaning of widebody aircraft

Florian Schröder, IGD: Visualization of meteorological data (pseudo-satellite images and video sequences) for the layperson

Prof. Dr. Cetin Morris Sonsino, LBF: Stress analysis of weld joints under multi-axis load conditions

Adam K. Zaboklicki, IPT: Laser-assisted press forming process – a contribution to innovation in forming technology

Dr. Roland Franz, Dr. Otto-Götz Piringer, IVV: Process for assessing plastic packaging for compliance with food safety regulations

1 *Herbert Wolter of the Fraunhofer ISC in his laboratory: He developed an amalgam substitute based on ORMOCER® materials.*

2 *George Sakas demonstrating the system he developed to visualize ultrasound data in 3-D.*

3 *Christian Backert and Hans Bloß with their new high-speed video system.*

1998

1999

1996

Dr. Georgios Sakas, IGD: System for 3-D ultrasound tomography based on conventional 2-D ultrasound devices

Martin Kemmerling, Gerhard Königsmann, Hans-Jürgen Schliepkorte, IMS: Design and implementation of a multifunctional digital communication system

Christian Backert, Hans Bloß, IIS: Digital high-speed video system

Christian Boehme, Andreas Michanickl, WKI: Process for the recovery of wood chips and fibers from timber materials

Dr. Paul Blank, Dr. Andreas Krell, IKTS: Al203 ceramics structured on a sub-micrometer scale as a material for tools and human implants

Dr. Eckhard Waschkies, IZFP: Ultrasound method for the online monitoring of spot welding processes

1997

Harald Egner, Rudolf Neumann, Werner Bähr, TEG: UltraScan-CD 40"/56" crack detector

Johannes Doll, Dr. Michael Krausa, Dr. Günter Hambitzer, ICT: Sensor system for the rapid on-site detection of TNT explosives in soil and water

Dr. Peter Schlotter, Ralf Schmidt, Prof. Dr. Jürgen Schneider, IAF: White single-chip LEDs

Dr. Werner Riethmüller, ISIT: Single-chip 3-axis acceleration sensor with monolithically integrated evaluation circuits, including the associated manufacturing technology for surface micromechanical structures

Thomas Bolch, Harald Holeczek, Kuno Hölldampf, IPA: Innovative process and plant technology to generate structured functional layers in the manufacturing of sheet metal

Prof. Dr. Berndt Brenner, IWS: Induction-assisted laser processing of materials – a new class of effective manufacturing technologies

1998

Dr. Friedhelm Heinrich, ISIT: MPM-X multi-channel process monitoring system for the analysis and monitoring of plasma-assisted deposition and dry etching processes

Wolfgang Doleschal, Wolfgang Kluge, Dr. Heinz Kück, IMS: Method and apparatus for rapid, direct-write maskless optical lithography of semiconductor components

Wolfgang Funk, Dr. Jian Zhao, IGD: Copyright protection system based on digital watermarks (SysCoP)

Markoto Sajidman, IITB: Novel, hybrid fuzzy concept for the feedback control of a complex rheological production process

Dr. Hermann Mai, Reiner Dietsch, Thomas Holz, IWS: Development and industrial scale-up of a manufacturing process for ultra-precise X-ray mirrors

Dr. Klaus Rose, ISC: Material and technological development of UV-hardened protective coatings for PMMA lenses

1999

Roland Blach, Andreas Rößler, Ulrich Häfner, IAO: "Lightning" virtual reality core system for the rapid creation of 3-D environments

Michael Füner, Prof. Dr. Peter Koidl, Dr. Christof Wild, IAF: Plasma deposition method for large-area diamond wafers

Dr. Mathias Herrmann, Dr. Manfred Nebelung, Dr. Christian Schubert, IKTS: Development of materials and technology for silicon nitride heating elements for cooking hobs

Dieter Hoffmann, Guido Bonati, Gunther Schmidt, ILT: Diode-pumped high-performance lasers

Prof. Dr. Rudolf Fahrig, ITA: Prevention of chemotherapy resistance

Robert Friedrich, Stefan Meltzer, Ernst Eberlein, IIS (representing the entire working group): WorldSpace digital satellite radio

2000

Christoph Schaeffer, IPA: Service robots – ready for the market

Dr. Thomas Graeve, IGB: The use of three-dimensional cell structures in test systems and transplants

Dr. Dieter Schneider, Dr. Thomas Schwarz, IWS: Laser-acoustic measurement device for nanotechnology

- Research alliance comprising the Fraunhofer Institutes for Silicate Research ISC, for Ceramic Technologies and Systems IKTS, for Manufacturing Engineering and Applied Materials Research IFAM, for Mechanics of Materials IWM and for Non-Destructive Testing IZFP, together with the Deutsches Zentrum für Luft- und Raumfahrt (DLR) and research partners in industry: Active vibration damping using adaptronic materials

2001

Dr. Randolf Hanke, Dr. Ulf Hassler, Thomas Wenzel, IIS: ISAR – Intelligent System for Automatic Radioscopy

- Joachim Fleißner, Dr. Harald Schneider, Dr. Martin Walther, IAF, together with colleagues from AEG Infrarot-Module GmbH: High-resolution thermographic camera

Dr. Volker Gengenbach, IITB: Automatic, video-based aircraft docking guidance system

Dr. Franz-Josef Pfreundt, Dr. Konrad Steiner, ITWM: Microstructure simulation

Dr. Stefan Schillberg, IUCT: Molecular farming – production of recombinant proteins in plants (special prize)

2002

Dr. Ralf Heckmann, Onno Garms, Mike Schäfer, SCAI: Efficient solution for industrial packaging problems in two and three dimensions

Manfred Knothe, Ulrich Klocke, Wolfgang Riedel, Helmut Wolf, IPM: Laser-based cinema film exposure system

Dr.-Ing. Hannelore Friedrich, IKTS: Disintegration of sewage sludge using high-power ultrasound

1 *Jian Zhao developed a digital watermarking system for computer files.*

2 *The prizewinners from the Fraunhoher IKTS with the silicon nitride that forms the basis for their process for manufacturing heating elements for cooking hobs.*

3 *Volker Gengenbach with his automatic aircraft docking guidance system.*

4 *Ralf Heckmann and his colleagues at the Fraunhofer SCAI devised a system to automate the packaging of differently shaped articles.*

2003

Jürgen Goetz, Joachim Montnacher, TEG, Wolfgang Kappes, Bernd Rockstroh, IZFP: Mechanized and automated in-situ underbody ultrasound test apparatus for high-speed train (ICE) wheelsets (special prize)

Dara Fatehi-Varkani, IPK: Track-integrated optical wheel geometry measurement for railway rolling stock

- Dr. Peter Dannberg, Dr. Michael Popall, Mike Gale, Prof. Dr. Mats Robertsson, ISC, with a total of 16 partners from research and industry: ORMOCER®s as a material for data transmission

2003

Dr.-Ing. Bernd Hellingrath, Axel Wagenitz, Jürgen Wloka, IML: OTD-SIM – a new approach to designing and assessing processes in contract and supply chain management

Dr. Ulrike Schulz, Peter Munzert, Dr. Norbert Kaiser, IOF: AR-hard® scratch-resistant, low-reflection coating for transparent plastics

1 *The prizewinners from the Fraunhofer ILT developed an automated generative method for the manufacture of dental prostheses.*
2 *The design of the "Aachen lamp" used to manufacture very large scale integrated circuits was the outcome of a collaborative project involving scientists from the Fraunhofer ILT.*
3 *Ulrich Priber and Jürgen Schönitz of the Fraunhofer IWU developed a polishing and grinding system for the paper industry.*

- Gheorghe Ardelean, Dr. Jochen Friedrich, Oliver Gräbner, Alexander Molchanov, Prof. Georg Müller, IISB, together with colleagues from SCHOTT Lithotec AG: Development of an optimized process for growing highly pure calcium fluoride crystals

Dr.-Ing. Wilhelm Meiners, Dr.-Ing. Christoph Over, Dr. Konrad Wissenbach, ILT: Generative production method for the automated manufacture of dental prostheses

2004

Eric Allamanche, Dr.-Ing. Jürgen Herre, Markus Cremer, IDMT: AudioID – robust, content-based identification of audio signals

Sven Carsten Lange, IPT: Minimally invasive, multifunctional biopsy needle made of carbon-fiber-reinforced plastic for MR-assisted intervertebral disk displacement therapy

Dr.-Ing. Thomas Wiegand, Detlev Marpe, Dr.-Ing. Heiko Schwarz, HHI: Development of the H.264/AVC video coding standard

- Dr. Klaus Bergmann, Dr. Jürgen Klein, Dr. Willi Neff, Sven Probst, Ralf Prümmer, Stefan Seiwert, Konstantin Walter, ILT, together with colleagues from RWTH Aachen and the companies AIXUV and Philips Extreme UV: The "Aachen lamp", an extreme UV light source for the manufacturing of very large scale integrated semiconductor chips

2005

Dr. Carsten Lojewski, ITWM: PV-4D – parallel visualization in four dimensions

- ▲ Prof. Dr. Karsten König, IBMT: Lasers for use in nanomedicine

Dr. Dieter Vogel, Dr.-Ing. Jürgen Keller, Prof. Dr. Bernd Michel, IZM: Product reliability in micro- and nanotechnology using nanoscale deformation analysis

Dr.-Ing. Ulrich Priber, Jürgen Schönitz, IWU: Smart polishing and grinding system for the paper industry

2006

Dr. Thomas Peschel, Christoph Damm, Dr.-Ing. Volker Guyenot, IOF: Minimally invasive heart valve transplant involving the transvascular implantation of a heart valve prosthesis

Prof. Dr. Berndt Brenner, Frank Tietz, IWS: Hardening of the surface-near region through localized nanoscale precipitation – a new process for the wear protection of precipitation-hardenable materials

- Dr. Andreas Bräuer, Dr. Peter Dannberg, Dr. Sergey Kudaev, Dr. Peter Schreiber, IOF, together with colleagues from OSRAM-OS, Siemens VDO and Carl Zeiss Jena GmbH: High-power diodes for use as a light source

Dr.-Ing. René de la Barré, Dr.-Ing. Siegmund Pastoor, David Przewozny, HHI: Interactive 3-D visualization with gesture interaction

Dr. Christoph Wild, Dr. Eckhard Wörner, Dietmar Brink, IAF: High-precision diamond hollow spheres for inertial confinement fusion (special prize)

1 *Researchers from the Fraunhofer IVV sample low-fat sausage for which they invented a manufacturing process.*

2 *The 2008 Stifterverband Science Prize went to researchers from the Fraunhofer IPA and the German Cancer Research Center. They developed a new fabrication process for biochips.*

2007

Clemens-August Thole, Prof. Dr. Rudolph Lorentz, Rodrigo Iza-Teran, SCAI: Compression of simulation results

Dr. Ruth Houbertz-Krauß, ISC: Integration of optical waveguides, manufactured using TPA processes in one and the same ORMOCER®, on printed circuit boards

- ▲ Dr.-Ing. Klaus Müller, Dr.-Ing. Peter Eisner, Dipl.-Ing. Christian Zacherl M.Sc., IVV: Manufacturing process for low-fat meat products

Prof. Dr. Walter Trösch, Dr.-Ing. Werner Sternad, IGB, and Dr.-Ing. Harald Hiessl, ISI: Decentralized urban infrastructure system DEUS 21

2008

Walter Glaubitt, Dr. Jörn Probst, ISC: Bioresorbable non-woven fabric made of silica gel fibers for the treatment of slow-healing wounds and burns

Dr. Rainer Kübler, IWM: Low-damage, laser-induced cutting method for flat glass

- Dr. Stefan Güttler, Martin Gröning, Peter Willems, Bernd Biesinger, IPA, together with colleagues from the German Cancer Research Center (DKFZ): An efficient manufacturing process for highly complex biochips

Dr. Ingo Krisch, Michael Görtz, Dr.-Ing. Hoc Khiem Trieu, IMS: Development of a fully implantable visual prosthesis and its successful trial use in a human study

THE PRIZES

Joseph von Fraunhofer Prize

This prize has been awarded by the Fraunhofer-Gesellschaft every year since 1978, in recognition of outstanding scientific work by members of its staff leading to the solution of application-oriented problems. Each prize is today endowed with a sum of 20,000 euros.

Technology Prize for human-centered technology (▲)

The Technology Prize for human-centered technology, worth 10,000 euros, was instituted by former Executive Board members and institute directors of the Fraunhofer-Gesellschaft in association with external patrons. It is awarded on a two-yearly basis for research and development work that makes a substantial contribution to improving people's quality of life and enabling them to remain active up to an advanced age.

Stifterverband Science Prize (●)

The Stifterverband (Donors' Association for the Promotion of Humanities and Science) sees its role as that of an intermediary between industry and science. Its science prize, worth 50,000 euros, is awarded in recognition of scientific excellence in applied research projects carried out by Fraunhofer Institutes in collaboration with industry and/or other research organizations. The prize is awarded biennially.

Abbreviations

The following abbreviations are used to designate the Fraunhofer Institutes for:

HHI: Telecommunications, Heinrich-Hertz-Institut
IAF: Applied Solid State Physics
IAO: Industrial Engineering
IBMT: Biomedical Engineering
ICT: Chemical Technology
IDMT: Digital Media Technology
IFAM: Manufacturing Engineering and Applied Materials Research
IGB: Interfacial Engineering and Biotechnology
IGD: Computer Graphics Research
IIS: Integrated Circuits
IISB: Integrated Systems and Device Technology
IITB: Information and Data Processing
IKTS: Ceramic Technologies and Systems
ILT: Laser Technology
IML: Material Flow and Logistics
IMS: Microelectronic Circuits and Systems
IOF: Applied Optics and Precision Engineering
IPA: Manufacturing Engineering and Automation
IPK: Production Systems and Design Technology
IPM: Physical Measurement Techniques
IPT: Production Technology
ISC: Silicate Research
ISI: Systems and Innovation Research
ISIT: Silicon Technology
ITA: Toxicology and Aerosol Research, later renamed Fraunhofer Institute for Toxicology and Experimental Medicine ITEM
ITWM: Industrial Mathematics
IUCT: Environmental Chemistry and Ecotoxicology, later renamed Fraunhofer Institute for Molecular Biology and Applied Ecology IME
IVV: Process Engineering and Packaging
IWM: Mechanics of Materials
IWS: Material and Beam Technology
IWU: Machine Tools and Forming Technology
IZFP: Non-Destructive Testing
IZM: Reliability and Microintegration
LBF: Structural Durability and System Reliability
SCAI: Algorithms and Scientific Computing
WKI: Wood Research, Wilhelm-Klauditz-Institut
and
TEG: Fraunhofer Technology Development Group

COMMITTED TO THE FUTURE

It is people who give an organization its strength and dynamism, even after 60 years. With brilliant ideas and a great deal of commitment, over 15,000 women and men ensure that the Fraunhofer-Gesellschaft still acts as a locomotive for innovation today. They develop innovative processes, products and services that give companies in Germany and Europe a technological edge, and they provide answers to global challenges. We invited six of our researchers to the Fraunhofer Forum in Berlin. Each of them stands for an area that promises "progress" in the best sense of the word and fulfils important human needs. We spoke with them about their work, their visions and the conditions under which innovations can succeed.

? *"What kind of stimulus generates new ideas, and what framework does a good project need in order to flourish?"*

! **Thomas Wiegand:** "We have tracked trends and given thought to how we can influence market developments with our know-how. Our area of expertise is processing and transmitting image data. The number of pixels in displays will continue to grow and this is a development that can be used for something other than just building bigger and bigger television sets. We think that the time is ripe for three-dimensional television. The first displays that do not require special eyewear to watch are coming onto the market. Because the technology is now available, demand for 'content' is on the rise, and if that is to mean something other than animated films, then depth of field will have to be computed while shooting. That concerns the first part of our project. The second, larger part involves encoding the content and delivering it to the end user. In the past, our most important decision was to participate in the standardization process for video compression. We helped to develop the H.264/MPEG4-AVC format. Meanwhile, it is the standard for mobile phones, iPods, Blu-ray Discs, Internet streaming and HDTV. Five years ago it was merely a document on my laptop; today it is used by about one billion terminals! Isn't that amazing?"

Andreas Reimann: "What's missing in certain areas of the biosciences is application-oriented research. But combining research and application at Fraunhofer really functions perfectly. One important approach here is 'translational research,' which endeavors to transfer laboratory results to clinical practice as efficiently as possible. This all functions well within our institute, but even better if you take advantage of the interdisciplinary possibilities at the interface between the natural sciences and engineering."

Heike Mertsching: "This collaboration is an opportunity, but also a challenge: We work on artificial, three-dimensional tissues with the aim of mitigating the limited supply of donor organs and offering a solution to the problem of organ rejection. In addition, we would like to see them becoming established as an alternative to animal testing. Neither of these technologies has been able to achieve a breakthrough because the manual manufacturing techniques are so expensive. Automated processes would accelerate production and improve quality. Representatives from the Fraunhofer Groups for Life Sciences and Production sat down together to address this issue – and at first failed to communicate properly for months. The engineers wanted standardized requirement specifications.

{PROF. DR. HEIKE MERTSCHING} IS A HUMAN BIOLOGIST WHO HEADS THE DEPARTMENT OF CELL SYSTEMS AT THE FRAUNHOFER INSTITUTE FOR INTERFACIAL ENGINEERING AND BIOTECHNOLOGY IGB. SHE IS COORDINATING A PROJECT AIMED AT THE MASS PRODUCTION OF ARTIFICIAL SKIN – ONE OF THE PROJECTS THAT IS BEING CO-FINANCED BY THE FRAUNHOFER FUTURE FOUNDATION. TO CONDUCT THIS WORK, SHE JOINED FORCES WITH THE FRAUNHOFER INSTITUTES FOR PRODUCTION TECHNOLOGY IPT, FOR MANUFACTURING ENGINEERING AND AUTOMATION IPA, AND FOR CELL THERAPY AND IMMUNOLOGY IZI.

We biologists did not realize how much detail was expected and thought we had already provided sufficient documentation. So it was all rather difficult to start with, but we have overcome our differences in the meantime.

Now we are having lots of fun with the collaboration. I really enjoy the situation at the Fraunhofer campus in Stuttgart. If I need to know something about chemistry or robotics, I just go over there and ask, or we exchange our ideas over lunch."

Stefan Reber: "A serendipitous encounter is an effective way to promote innovation. But in this respect I am not such a fan of a campus, because networking diminishes exponentially with distance – anything that is more than 100 meters away is already more difficult. Phones and mail do help, but the thing that works best is meeting face to face."

Mareike Schneider: "The best thing about a campus is that many aspects of our work are facilitated by being able to make use of a wider range of laboratory facilities and scientific instruments. When several institutes share the same site, as is the case here in Dresden, it means we have many more possibilities available, thanks to the high standard of equipment."

Andreas Reimann: "With reference to our own particular project, I would like to cite another stimulus for new ideas, namely societal visions: Among the UN's stated millennium development goals or in the declaration of the G-8 nations at Heiligendamm, there are passages that refer to combating infectious diseases. Our institute has many years of experience in the use of plant systems to manufacture proteins. That is how we arrived at the idea of producing the proteins of the malaria pathogen, which can be used to manufacture vaccines and additionally to generate specific antibodies. Plant-based production methods would allow virtually unlimited quantities to be manufactured. It is essential that the production process should be automated, monitored with sensors, and comply with the good manufacturing practice regulations for pharmaceutical products. Later, the vaccine – and ideally the entire system – could be deployed inexpensively in developing nations. This principle could be transferred to other pharmaceutical products."

Andreas Bräuer: "The desperation of a customer actually gave a leg-up to our inspiration. A manufacturer of mobile phone cameras literally pleaded with us: 'You have to make camera systems more compact! It's a marketing argument for me.' But there are physical limits for reducing the length of single-channel cameras. So we looked around in nature and came across the compound eyes of insects. The basic principle behind them is that many channels are used to record the information and the brain puts it together to form an image. We first produced a model to replicate the principle of the housefly's eye. We know that the compound eye fulfils its function in nature because flies always manage to avoid being swatted. But it has a very low resolution. So now we would like to find out which variants allow for higher resolutions and for the best technical utilization."

Mareike Schneider: "That precisely reflects the Fraunhofer philosophy: Market needs manifest themselves in the form of research contracts received by our institutes."

{DR. STEFAN REBER}
HEADS THE GROUP FOR CRYSTALLINE SILICON MATERIALS AND THIN-FILM SOLAR CELLS AT THE FRAUNHOFER INSTITUTE FOR SOLAR ENERGY SYSTEMS ISE. HE IS CURRENTLY HEADING A RESEARCH PROJECT THAT AIMS TO LOWER THE COST OF SOLAR CELLS THROUGH THE USE OF METALLURGICAL SILICON. THIS IS ANOTHER OF THE PROJECTS BEING FUNDED BY THE FRAUNHOFER FUTURE FOUNDATION.

Heike Mertsching: "But don't we also feel some kind of pressure from within our own selves?"

Andreas Bräuer: "Yes, it's something like a spirit of sportsmanship."

Heike Mertsching: "When I am fascinated by an idea, I begin experimenting and want to know more until I run up against a brick wall. Then I look for an expert who can help me out. The great thing about being at Fraunhofer is that just about every specialty is represented here!"

? "How much cooperation is needed, and when is isolation also helpful?"

! **Mareike Schneider:** "First of all, we are not going to go reinvent things if Fraunhofer colleagues already have a solution. That would be a case where cooperation makes sense. Basically, however, we all have the know-how internally for our current project. We would like to develop micro fuel cells for mobile devices based on two technologies. For solid oxide fuel cells (SOFC), which could serve as a source of electricity for camping, for example, all technologies, from materials to system integration, are present at the institute. In this case we must not – and are not allowed to – 'contaminate' our patent portfolio by collaborations, in particular with external partners. We would like to deploy PEM fuel cells, which can be produced in even smaller power classes, in, for example, charging devices for mp3 players. To do this, we could use multi-layer ceramic structures for the mechanical and electrical integration. Microreaction technology would be the bailiwick of our colleagues at the Fraunhofer ISE."

? "So the possibilities for cooperation at Fraunhofer are a plus, and we have heard about yet another one: The high standard of equipment. Mr. Reber, you have just inaugurated a technological and evaluation center for silicon materials research ..."

! **Stefan Reber:** "… for our project that aims to make photovoltaics affordable in the long run. To produce solar cells from wafers, one needs highly pure silicon. Five years ago, the world's annual production of this material was less than 50,000 metric tons. 100,000 metric tons have been announced for the end of 2010, and trends are suggesting further increases. Purifying is complex, nevertheless, 70 to 80 percent of the highly pure silicon is lost as machining waste during production and is therefore worthless. So we hit on the idea of manufacturing the wafers from impure silicon – whereby impure still means 99.999 percent pure – and purifying the material afterwards. Another alternative would be to use wafers made from even less pure silicon and deposit thin, highly pure layers on their surface that are capable of acting like solar cells. That would avoid us having to make any significant changes to the production sequence and we could quickly make an alternative available to the market. This would facilitate growth in the industry."

{DR. ANDREAS BRÄUER}
HEADS THE WORK ON MINIATURIZED OPTICAL SENSORS AND CAMERAS BASED ON INSECT EYES AT THE FRAUNHOFER INSTITUTE FOR APPLIED OPTICS AND PRECISION ENGINEERING IOF. DR. BRÄUER, WHO DIRECTS THE DEPARTMENT OF MICROOPTICAL SYSTEMS, AND TWO INDUSTRY PARTNERS RECEIVED THE 2007 GERMAN PRESIDENT'S FUTURE PRIZE FOR THE DEVELOPMENT OF HIGH-EFFICIENCY LED MODULES.

? "Your Institute is booming like never before. This means staff recruitment, procurement processes, committee meetings. How much time do you have left to devote to science?"

! **Stefan Reber:** "Well, does managing a project or discussing things with doctoral candidates come under the heading of science?" I think so, because it is during discussions of that kind that ideas spring up. Don't go thinking that I tinker with any machines myself. Sometimes I can't even find the light switch in the lab. But that makes no difference to me, I knew that my path would lead in that direction. By the same token, the administrative work is indeed barely manageable, particularly in a growth phase such as this one. There are two factors above all that cost time: the tendering and procurement practices in compliance with public procurement directives and personnel recruitment."

Andreas Bräuer: "But the time spent is a good investment. Recruiting the wrong people would ultimately be very expensive."

? "How are the young people who come to you? Are they still full of crazy ideas?"

! **Thomas Wiegand:** "Students without crazy ideas – that would be a contradiction in terms. Besides, more often than not, crazy ideas help you to advance. I believe you should not burden students too much with the past work of others, then they find surprising solutions. I once sat a student down in front of an as-yet-unsolved problem. As a solution, he used an arithmetic operation that was so complicated that I myself would have never dared apply it for that task. Later on, we found out that even a standard PC was capable of handling his method."

Andreas Bräuer: "Naturally, we do take on the odd graduate who does require an investment because he or she will have to be trained. But some of them have a kind of productive playfulness. One time, an applicant came up to me and said that he had already built a digital projector in his spare time. People like that are real treasures!"

? "How did you end up at Fraunhofer?"

! **Stefan Reber:** "When I completed my physics degree in 1995, industry hardly had any jobs to offer. Ever since my dissertation, I knew that pure research was not for me, so I went to the Fraunhofer Institute for Solar Energy Systems ISE. I found environmental technology to be fascinating and since then I have remained faithful to the subject of silicon thin-film solar cells."

Mareike Schneider: "I became an environmental process engineer because I wanted to play an active role in environmental protection in my professional life as well as in my private life. I found work at an engineering firm too boring, and university research not hands-on enough, so I joined the Fraunhofer Institute for Transport and Infrastructure Systems IVI. A year ago I then transferred to the Fraunhofer Institute for Ceramic Technologies and Systems IKTS."

Heike Mertsching: "I used to work at the Hannover Medical School, one of the first German universities to establish facilities for growing tissue outside the body. While I was there, it became obvious to me that I would need the input

of many other disciplines to make progress with this 'tissue engineering'. I also looked for openings at Fraunhofer, because those disciplines are represented here. And then, in 2004, I started at the Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB."

Andreas Bräuer: "I was a physicist at the University of Jena. After German reunification, a major reorganization of the university's faculties reduced the opportunities for applied research. But soon after the fall of the Iron Curtain, Fraunhofer became involved in eastern Germany and our first institute director, Professor Wolfgang Karthe, developed the best concept for an institute for applied optics and precision engineering, a combination of competencies that did not exist at Fraunhofer until that time. Like myself, Professor Karthe originally came from the University of Jena and he had been asked to build up the team for today's Fraunhofer IOF from members of the University and the former Academy of Sciences."

Thomas Wiegand: "I also came to Fraunhofer as a result of integration: During my studies and doctoral work, I spent considerable time in Japan and the USA. I was then given a job as a group leader at the Heinrich-Hertz-Institut, which was an institute performing basic research at the time. Ever since it was integrated in the Fraunhofer-Gesellschaft, the HHI has steered closer to the market."

Andreas Reimann: "After completing my doctoral thesis in Paris, I first left the field of science and worked for a firm of business consultants. It gave me a completely different perspective, but I did miss the contact with research. Then my former supervisor, Professor Rainer Fischer, who had meanwhile built up the Fraunhofer Institute for Molecular Biology and Applied Ecology IME in Aachen, offered me a very interesting position. So, for the past year now, I have been coordinating a major project at the Fraunhofer IME – a perfect combination of science and management."

? *"Relinquishing the sciences to found a company – would that be an option for others here?"*

! **Heike Mertsching:** "I founded a firm once with some colleagues. We had a good idea, but not a clue about business, and so we went belly up. I learned a lot from that, but for my part, I prefer doing research and development."

Andreas Bräuer: "I feel the same way: We drew up a business plan for a company, but founding it is something for young people. Anyway, what we do at Fraunhofer is not much different from work in a company, when you realize that the institutes have to finance themselves to a large extent."

Stefan Reber: "Sometimes I do long for a cozy job in industry. If you have success with a product there, you can really build up your reserves. That is incomparably more difficult at Fraunhofer: We sell ideas. I now have the opportunity to direct findings from research towards the market. Every scientist dreams that the fruit of his or her work will one day be available as a commercial product."

Mareike Schneider: "So ultimately we have all chosen the middle ground between basic research and business."

{PROF. DR. THOMAS WIEGAND}
IS HEAD OF THE DEPARTMENT OF IMAGE SIGNAL PROCESSING AT THE FRAUNHOFER INSTITUTE FOR TELECOMMUNICATIONS, HEINRICH-HERTZ-INSTITUT, HHI AND PROFESSOR AT THE TECHNICAL UNIVERSITY OF BERLIN. WIEGAND MADE MAJOR CONTRIBUTIONS TO THE VIDEO COMPRESSION PROCESS H.264, FOR WHICH HE RECEIVED TWO TECHNOLOGY AND ENGINEERING EMMY AWARDS, IN 2008 AND 2009. AT THE PRESENT TIME, HE AND HIS TEAM, TOGETHER WITH PARTNERS FROM THE FRAUNHOFER INSTITUTE FOR INTEGRATED CIRCUITS IIS, ARE ADVANCING THE DEVELOPMENT AND STANDARDIZATION OF TECHNOLOGIES FOR 3-D TELEVISION.

? "Do you often have to answer questions about the relevance of your research and its consequences?"

! **Andreas Reimann:** "We no longer have to constantly justify the fact that we genetically modify plants, as we used to in the past. Our task is education, because lack of knowledge is often the reason for fear. Our institute director sets a good example by giving lectures to local administrative bodies, the church council, or as part of lecture series for senior citizens."

Heike Mertsching: "Some people associate our work with 'Frankenstein's lab' – I've even used that myself as an opening to lectures, for instance when speaking at a rural women's association. But the question most frequently asked by members of the audience is whether only wealthy people will be able to afford these replacement tissues. I then explain that it is precisely our efforts to automate the process that will make the products more affordable."

Thomas Wiegand: "This work is becoming more and more relevant for students. I can even thrill the theoretical people when I show them that what they calculated can be applied in practice a certain way. As for the social relevance of our work, I could argue that video telephony contributes to improving the CO_2 balance. But in general you could say that any kind of technology can be linked in one way or another to a larger story, that can then be colored negatively or positively."

Mareike Schneider: "Education still remains a significant point. While renewable energies enjoy broad acceptance on the whole, that is no longer quite the case for fuel cells. A lot of expectations were raised early on, which have not been fulfilled. And many people have started asking whether the production of hydrogen doesn't require too much energy. But our fuel cells operate with ethanol and camping gas, and not with hydrogen, precisely so that they can use renewable resources. Explaining what we do and why is a request that I encounter more and more often."

? "So you have to be scientists, research managers and PR experts in one?"

! **Stefan Reber:** "… and our own critics! It is not sufficient to present your own actions in a positive light, we also have to keep asking ourselves: Is what we are doing worthwhile and useful? I mentioned before how many hundreds of thousands of metric tons of silicon are produced annually. That can't be done without chlorine chemistry. Is expanding this chlorine chemistry what we really want? These are questions to which we must provide a response, in spite of the positive image of photovoltaics."

Mareike Schneider: "But the subject you just addressed, namely that we have to fulfil several functions at the same time, is precisely why we chose this employer. When someone here considers taking up an offer from the industry, I point to the enormously broad range of tasks at Fraunhofer and the liberty we are given to be creative. Here, everyone can try out what abilities he or she has and wishes to develop."

{DR. MAREIKE SCHNEIDER}
IS SETTING UP A GROUP FOR ENERGY SYSTEMS AT THE FRAUNHOFER INSTITUTE FOR CERAMIC TECHNOLOGIES AND SYSTEMS IKTS AND SHE IS DEPUTY COORDINATOR FOR THE FOUNDATION PROJECT "MICRO FUEL CELLS IN MULTI-LAYER CERAMICS FOR VOLUME PRODUCTION", WHICH IS BEING CARRIED OUT BY THE FRAUNHOFER IKTS AND THE FRAUNHOFER ISE.

? *"Lots of praise for the Fraunhofer-Gesellschaft as an employer. We are now celebrating our 60th anniversary. What thoughts do you have on this particular occasion?"*

! **Andreas Reimann:** "I am the one who has spent the least time here, and I must say it feels good to be with Fraunhofer. On the one hand, it is comforting to know that the organization has a solid reputation based on 60 years of reliable work. On the other hand, there is the promise of more to come, because the process of renewal is by no means over. We are using what already exists and building up from there. Our institute in Aachen is a perfect example, having developed from the founding idea to its realization within just a few years."

Stefan Reber: "The least that can be said is that the principle of 'If you earn your keep, all will be well' is an effective instrument if you want to remain at the forefront of developments, because it means you are in tune with the market. Occasionally, an area of research will become outdated and be banished by the market. But all in all, this has permitted us to remain eternally young."

Andreas Bräuer: "Naturally, it is difficult to hold together and steer such a large system of kingdoms – and an institute director does control a small kingdom – and that is noticeable. But the fact that the institutes are given a lot of individual freedom in their activities, within certain boundaries, makes people more inventive. And it's no accident that we are observed worldwide and are quite envied."

Thomas Wiegand: "I don't know if there is any organization that is quite as diversified in its focus as Fraunhofer. When it comes to being multifaceted, we could hardly be doing better."

Heike Mertsching: "Fact is, we are not an automaker that has been developing in one single direction for the past 60 years. Our content changes, and will continue to do so in the future."

? *"How about wagering a look at the world in 60 years: How will your children and grandchildren view the issues you are dealing with here and today?"*

! **Thomas Wiegand:** "The past has taught us that forecasts are unreliable because unforeseen influences can steer developments in an entirely new direction. Claude Shannon's paper on information theory – the most important publication in my discipline – was written in 1948. But do you think he could have predicted the Information Age? The transistor, which was invented at about the same time as the publication of Shannon's paper, only took on a greater significance when integrated circuits came onto the scene. Computers were gigantic mainframes. It took the PC – a marketing gimmick, if you will – and even more so, the Internet, to spark a revolution. So you might as well forget it! Perhaps I can make a prediction about how things will be in 15 years. I am hoping that by then 3-D TV will be taken for granted and that today's television standards will seem as old-fashioned as black-and-white TV appears to us today."

{DR. ANDREAS REIMANN}
WORKS IN THE CONTRACT ACQUISITION MANAGEMENT DEPARTMENT AT THE FRAUNHOFER INSTITUTE FOR MOLECULAR BIOLOGY AND APPLIED ECOLOGY IME. RIEMANN, A BIOLOGIST, MANAGES A PROJECT TO DEVELOP INNOVATIVE TECHNOLOGIES FOR BIOPHARMACEUTICAL PRODUCTS IN MICROORGANISMS AND PLANTS. THE FRAUNHOFER IPT AND THE FRAUNHOFER IIS ARE WORKING TOGETHER WITH THE FRAUNHOFER IME ON THIS PROJECT, WHICH IS FUNDED BY THE FRAUNHOFER FUTURE FOUNDATION.

Andreas Bräuer: "I feel that communication with our 'everyday personal assistants' leaves much to be desired: I hate having to press keys and plug in jacks, and I really get mad when a device doesn't understand me. A lot will be happening in the domain of user interfaces, and hopefully we won't have to wait another 60 years: Devices will respond to eye movements, voice commands, and perhaps even brainwaves."

Stefan Reber: "It would be unthinkable if all of the efforts being invested in designing an energy supply based on renewable resources were not to succeed …"

Mareike Schneider: "… or so we hope at any rate. Even taking a conservative estimate of the predicted reserves of fossil fuels and uranium, then it's clear that they will be entirely depleted within the foreseeable future. Besides, none of us has the right to prohibit the rest of the world from aspiring to the lifestyle that we enjoy at present. We can therefore expect to have to deal with a significant increase in global energy consumption."

Heike Mertsching: "I am almost certain that regenerative therapies will be the state of the art when my children reach retirement age. My own personal aim is to combine complex tissue or organ parts to produce transplants that truly replicate body functions. We would then have a reliable alternative to animal testing and clinical trials, which are merely designed to test the toxicity or incompatibility of drug ingredients. That is why we are focusing our work on the intestine, the windpipe and the skin, because these are the organs through which drugs are absorbed by the human body. But the delivery system is not complete without taking into account the circulatory system, liver and kidneys. To integrate these key players and then draw conclusions regarding drug efficacy – that would be terrific."

Andreas Reimann: "I hope that, within the next 60 years, we will have found a vaccine against malaria that would enable us to reduce the 300 to 500 million new infections per year, and that our system will enable the countries most affected to establish their own preventive programs. Malaria is not only a plague in the purely pathological sense, but it also has an enormous impact on poverty and economic development."

Thomas Wiegand: "One thing that can be predicted is that new technologies will always take hold wherever they offer benefits to a majority of people that they can also afford. That is an aspect that is often ignored. How many science-fiction films feature gigantic spacecraft that fly to other planets? But most people don't see any benefit in such fantastic ideas, which is why this area of science hasn't progressed as far as its advocates might have predicted. So when you ask me to think about the world in 60 years, the best idea that I can think of is Fraunhofer research with its needs-based orientation."

Heike Mertsching: "I would like to get back to the students regarding the question about visions: In a certain sense, I see my graduate students and PhD candidates a little like children …"

Thomas Wiegand: "… which is why in German we refer to PhD supervisors as *'Doktorvater'* or *'Doktormutter'*..."

Heike Mertsching: "… and we pass our visions on to them and hope that they will take them further. When my doctoral candidates feel the same fascination with a subject as I do, it's just as rewarding as watching the progress of my own children."

THE FUTURE NEEDS RESEARCH.

Through its focus on applied research, Fraunhofer has taken on a special role that requires keeping a constant eye on the real wishes and needs of human society. For it is the ultimate aim of new technologies and products that they should be of benefit to people and help them to build a better future. People need health, security, energy, communication, the environment and mobility. In an intensive discourse, Fraunhofer has identified twelve 'Frontline themes – Tomorrow's opportunities'. These twelve frontline themes have been placed at the center of the organization's research portfolio, commensurate with their ability to make a significant contribution toward fulfilling these fundamental needs. The Fraunhofer Institutes continuously adapt their profiles to meet demand. To do so, they invest resources they have been granted as base funding by the federal and Länder governments and form networks enabling them to pool their distributed skills and expertise.

Sometimes, additional support is needed to provide the liberty that is required to enable creative ideas to be developed into viable innovations with a real-life orientation. Consequently, the Fraunhofer-Gesellschaft has obtained the approval of its public sponsors to establish a "Fraunhofer Future Foundation". The foundation derives its capital from the license-fee revenues generated by the successful marketing of mp3, an invention of the Fraunhofer Institute for Integrated Circuits IIS. The foundation supports foresighted research projects with a longer planning horizon that have need of more extensive funding. Its intent is to give the Fraunhofer-Gesellschaft a standalone position in selected areas of technology, enabling it to serve its function as a motor for innovation in the longer perspective. The foundation took up its work at the end of 2008. It is chaired by Professor Ulrich Buller, Senior Vice President Research Planning.

APPENDIX

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Fraunhofer Groups

Fraunhofer Information and Communication Technology Group
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- Algorithms and Scientific Computing SCAI
- Applied Information Technology FIT
- Communication Systems ESK (associated member)
- Computer Architecture and Software Technology FIRST
- Computer Graphics Research IGD
- Digital Media Technology IDMT
- Experimental Software Engineering IESE
- Industrial Engineering IAO
- Industrial Mathematics ITWM
- Information and Data Processing IITB
- Integrated Circuits IIS (associated member)
- Intelligent Analysis and Information Systems IAIS
- Medical Image Computing MEVIS
- Open Communication Systems FOKUS
- Secure Information Technology SIT
- Software and Systems Engineering ISST
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