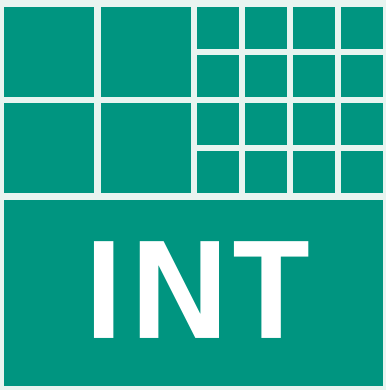
INT

Fraunhofer Institut
Naturwissenschaftlich-
Technische Trendanalysen

Annual Report 2008


INT

Annual Report 2008

Fraunhofer-Institut für
Naturwissenschaftlich-Technische
Trendanalysen INT

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Preface of the director

The Fraunhofer INT looks back at another eventful and successful year 2008. The pleasant development of recent years in contract research was continued, as was the Institute's adjustment process to the general Fraunhofer model.
In 2008, the number of employees financed by contract research rose by three, and new framework conditions becoming valid in 2009 promise further growth here. We expect a more continuous development in contract research in the years to come.

The first phase of the internal strategic alignment process of the Institute initiated in 2007 was concluded and documented in mid-2008 with a comprehensive strategic plan. It is the basis for the strategy for the coming years.

As to external developments, the fundamentally changing political and public perception of internal and external security continues. The redefinition of the role of national and international governmental and quasi-governmental institutions dealing with security and defense is by far not finished. It becomes evident that virtually all organizations with a strong need for long-term strategic alignment have a high demand for professional assessment and advice on long-term technological developments and their impacts on precautionary planning.

The Fraunhofer INT has intensified its support of civil preventive institutions (e.g. the Protection Commission of the German Federal Ministry of the Interior BMI, the German Federal Authority for Radiation Protection BfS, the German Federal Office of Civil Protection and Disaster Assistance BBK and the German Federal Criminal Police Office BKA). The Institute also enhanced its international cooperation on the integration of long-term technological developments into national defense planning (NATO, European Defence Agency, LoI6[1] cooperation).

Furthermore, the Fraunhofer INT increased its efforts to support civil European security research and associated planning and decision-making processes of European organizations (e.g. EU Commission, European Security Research and Innovation Forum ESRIF, European Parliament, EuroTech SRG) as part of a network of defense-oriented cooperation partners.

The Institute successfully continued its specialized research in the nuclear field. The number of projects the Fraunhofer INT carried out for medium-sized industrial companies on the suitability of electronic components for application in radiation environments kept increasing.

In light of this background, we are confident that the dynamic development of the Institute can be sustainably ensured. To create the infrastructure required for this, the Fraunhofer INT, in cooperation with the Fraunhofer headquarters, developed a master plan for the constructional expansion of the Institute elaborated by an architectural office in 2008. This plan includes a larger lecture room, a larger library and the establishment of further workplaces.
We are optimistic and confident to realize this expansion in the coming years.

At this point, my personal thanks go to the German Federal Ministry of Defence, which will continue to ensure the scientific basis of the Institute's work by providing base funding, for the fruitful and friendly cooperation.
Moreover, I would like to offer my thanks to all friends of the Institute, particularly to the trustees, for their support during this interesting and motivating phase of the Institute's history.

At the same time, I would like to thank all of the Fraunhofer INT's employees for their great commitment in recent years.

Dr. Uwe Wiemken

1 Cooperation agreement between France, Great Britain, Italy, Sweden, Spain and Germany

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Profile

The central mission of the Fraunhofer INT is the creation, maintenance and documentation of a comprehensive overview of the general research and technology landscape, from the viewpoint of both the scientific-technical analysis of reliability and relevance in terms of content and international structures, institutions and processes.

The objective of our work, which is financed by the base funding of the German federal ministry of defence (BMVg) and by civil contract research, is to ensure our ability to give reliable content-related assessments on all aspects of technological developments and their implications on society and precautionary planning.
Our main focus is on the long-term perspective, which supports and accompanies the definition of objectives. This general approach is complemented by in-depth studies and analyses whenever necessary.

In particular, experimental and theoretical research projects are carried out on nuclear-physical and electromagnetic problems. On the one hand, these projects serve to ensure our ability to provide assessments, advice and cooperation to the BMVg on the prevention against nuclear and electromagnetic threats. On the other hand, they also serve to market our historically grown competence in these fields.
The Institute's equipment includes state-of-the-art measuring technology, a wide range of laboratory equipment and large-scale devices, such as radiation sources, electromagnetic simulation units and special computer programs, and cannot be found in this combination in any other civilian institution in Germany.

The Institute in numbers

Personnel

In 2008, personnel capacity again increased in comparison to the previous year. The part of scientists in the whole staff climbed steadily in recent years and now accounts for 64%.
In addition to the employees listed in the table, there are constantly about 15 research and student assistants and two apprentices.
Furthermore, the Fraunhofer INT maintains a network of freelance scientists who are regularly integrated into the institute's work.

	2007 Occupied positions	2007 People	2008 Occupied positions	2008 People
Scientists	40,5	43	42,7	45
Graduates	11,5	13	12,5	13
Technicians, others	13,5	16	11,5	15
Total	65,5	72	66,7	73

Budget

The Fraunhofer Gesellschaft distinguishes between operating budget and investment budget.
The operating budget covers personnel and material expenses, while the investment budget covers the purchase of investment goods such as scientific equipment and computers.
The Fraunhofer INT's expenditure is financed by base funding from the BMVg on the one hand and

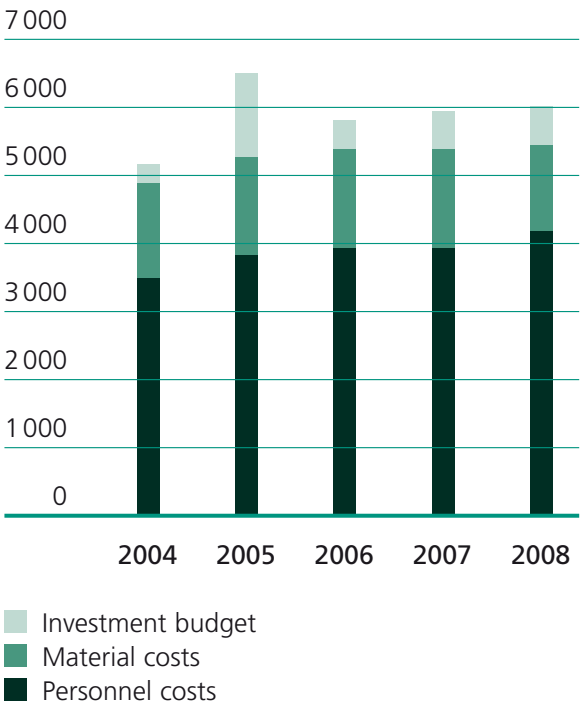
	Budget in 1000 €	2004	2005	2006	2007	2008
Expenditure	Operating budget	4 859,0	5 368,0	5 379,5	5 356,8	5 453,6
	thereof personnel costs	3 683,0	3 848,8	3 930,3	3 931,1	4 177,8
	thereof non-personnel costs	1 176,0	1 519,2	1 449,2	1 425,7	1 275,8
	Investment budget	390,0	1 133,7	425,3	560,2	569,2
	Total	5 249,0	6 501,7	5 804,8	5 917,0	6 022,8
Funding	Base funding	3 800,0	3 910,0	3 881,0	3 881,0	4 071,0
	Contract research	1 449,0	2 591,7	1 923,8	2 037,0	1 951,8

by income from research projects on the other hand. With a slight, tariff-driven increase in the base funding, the Institute was able to cover the funding of its budget with the income from contract research. By now, about a third of the Institute's budget is financed by contract research.

In 2008, the Fraunhofer INT worked on 60 different contract research projects, 27 for public clients and 33 for industrial clients. The greatest part of the Institute's income is generated in the area of public clients. However, the part of income from industry projects increases steadily.
The Fraunhofer INT's most important client is the German Federal Ministry of Defence.

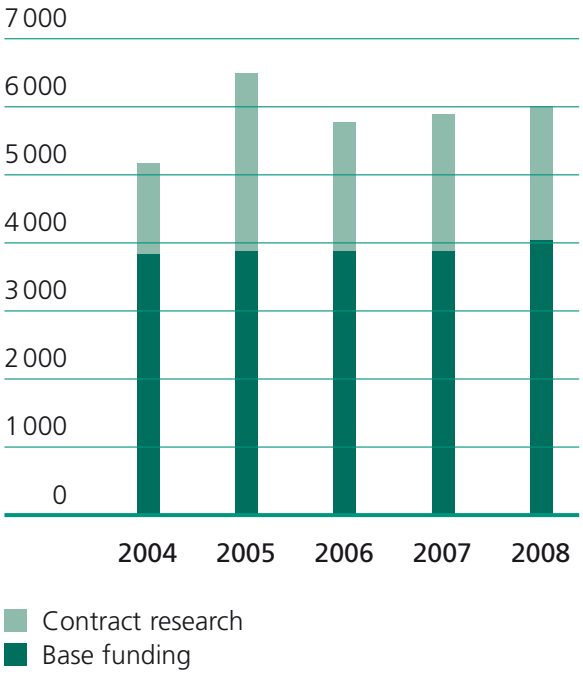
Budget from 2004 to 2008

in 1000 €



Financial development from 2004 to 2008

in 1000 €



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The Fraunhofer-Gesellschaft

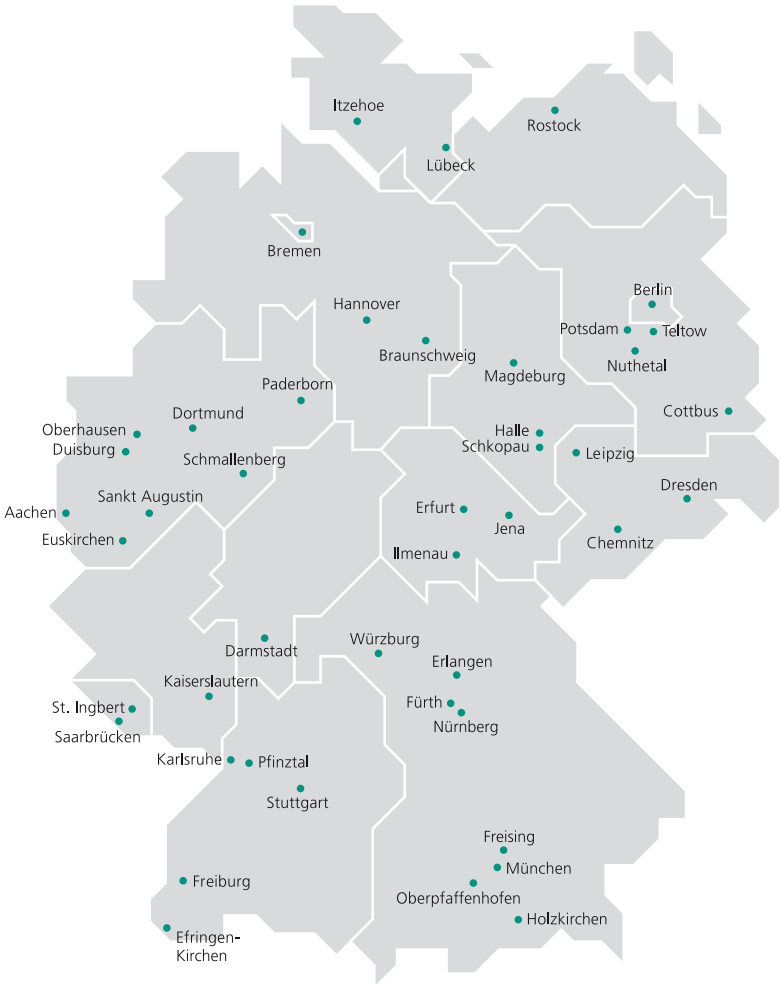
Research of practical utility lies at the heart of all activities pursued by the Fraunhofer-Gesellschaft. Founded in 1949, the research organization undertakes applied research that drives economic development and serves the wider benefit of society. Its services are solicited by customers and contractual partners in industry, the service sector and public administration.

At present, the Fraunhofer-Gesellschaft maintains more than 80 research units in Germany, including 57 Fraunhofer Institutes. The majority of the 15,000 staff are qualified scientists and engineers, who work with an annual research budget of € 1.4 billion. Of this sum, more than € 1.2 billion is generated through contract research.
Two thirds of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and from publicly financed research projects. Only one third is contributed by the German federal and Länder governments in the form of base funding, enabling the institutes to work ahead on solutions to problems that will not become acutely relevant to industry and society until five or ten years from now.

Affiliated research centers and representative offices in Europe, the USA and Asia provide contact with the regions of greatest importance to present and future scientific progress and economic development.

With its clearly defined mission of application-oriented research and its focus on key technologies of relevance to the future, the Fraunhofer-Gesellschaft plays a prominent role in the German and European innovation process. Applied research has a knock-on effect that extends beyond the direct benefits perceived by the customer: Through their research and development work, the Fraunhofer Institutes help to reinforce the competitive strength of the economy in their local region, and throughout Germany and Europe. They do so by promoting innovation, strengthening the technological base, improving the acceptance of new technologies, and helping to train the urgently needed future generation of scientists and engineers.

As an employer, the Fraunhofer-Gesellschaft offers its staff the opportunity to develop the professional and personal skills that will allow them to take up positions of responsibility within their institute, at universities, in industry and in society. Students who choose to work on projects at the Fraunhofer Institutes have excellent prospects of starting and developing a career in industry by virtue of the practical training and experience they have acquired.



The Fraunhofer-Gesellschaft is a recognized non-profit organization that takes its name from Joseph von Fraunhofer (1787–1826), the illustrious Munich researcher, inventor and entrepreneur.

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Technology Analyses and Forecasts (TAV)

Technology Analyses and Forecasts (TAV)

The task of the "Technology Analyses and Forecasts (TAV)" department of the Fraunhofer INT is to monitor scientific-technological developments at home and abroad as comprehensively as possible and to analyze them in terms of their long-term relevance for state and industry.
The aim is to acquire and evaluate information on the most important issues, results and activities in this sector in order to provide a basis for long-term technology forecasts and planning processes. In addition to this interdisciplinary task, the department works in detail on a number of special technological topics.

The department's main client is the German Federal Ministry of Defence (BMVg). Here, framework conditions resulting from new technologies are to be identified in time, so that they can be integrated into long-term planning with the highest possible benefit.
Furthermore, the department supports the BMVg in assessing new functional principles and technological developments scientifically and technologically. To an increasing degree, the department also works on projects for other public clients and clients from the industry.

On the basis of these framework conditions, the department's work comprises two fields:
- Technology Monitoring and Forecasts
- Technology Analyses

Increasingly, publicly available platforms are used to document and present work results.
That includes articles and permanent columns in professional journals, book publications and workshops as well as a series of reports entitled "Analysen und Expertisen zur Wehrtechnischen Vorausschau" published by the Fraunhofer INT.
The Fraunhofer INT series "Technologie, Verteidigung und Sicherheit" launched in 2004 in book form constitutes another platform in which the department publishes outstanding work results.

Furthermore, these work results flow into different international projects in which the Fraunhofer INT participates in the context of NATO or European cooperation.

Technology Monitoring and Forecasts

Technology monitoring aims to create and document a general overview of new scientific and technological developments. The basis for this is established by continuous observation and analysis of the international research landscape by means of assessing and analyzing relevant information sources. This includes technological/scientific magazines and information services, annual reports and results reports, magazines published by institutions with high R&D-relevance, descriptions and result presentations of international research programs as well as publications about technological future development analyses and forecasts.

TAV department also gathers information through immediate contacts with external experts from research, industry and public authorities.
This includes discussions as well as the initiation, placing and evaluation of analyses and expert opinions regarding specific technological topics.
At present, the entire content of the information diversity, which is monitored by TAV, encompasses approx. 40 scientific/technological fields which can roughly be divided into the four topic clusters Matter & Energy, Information & Knowledge, Life & Nature and Economy & Society.

An important work result of Technology Monitoring is the permanent column "Neue Technologien" established 10 years ago in the monthly journal "Strategie & Technik" which reports on current technological developments.

An essential task of the department is to transfer the information diversity gathered by the monitoring process into a complete image of future developments of science and technology.
The basis of this task is the identification of main trends in the above mentioned topics and the analyses of their essential interactions.
Here, the "Wehrtechnische Vorausschau (WTV)" constitutes the most important achievement.
Its purpose is to inform planners in the fields of armaments, military and security politics in the entire operational area of the BMVg about long-term technology developments.

Technology Analyses and Forecasts (TAV)

The work on the current four-volume issue of the WTV was finished in 2007.
After that, work was started on two complementary topics. One focus lies on an overview of main development tendencies in the civilian research and technology landscape with the title "Allgemeine Technologievorausschau (ATV)".

dical spectrum as well as an in-depth description of selected methods.

Another focus lies on the continuation of the systematic compilation of future studies and the analyses of their content and methods.

The staff of the department Technology Analyses and Forecasts
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Another focus in the current forecasts lies on the technological aspects in the area of public security. This allows the department to expand its defense competence into the area of civil security.

In addition to the scientific-technological competence necessary for the professional work, the special character of the department's tasks, to a growing extent, necessitates the dealing with basic, methodically oriented questions in the fields of early technology detection, prognostics and general futurology.

In 2008, the department developed the first general overview of the methods of futurology which includes a categorization of the metho-

Technology Analyses

On the one hand, the department's main focus lies on issues in which it already has accumulated an extensive knowledge through special studies and analyses in the past.
On the other hand, the department has to develop competence in technological areas in which there will be an increased demand for information in the future for customers such as the BMVg. In addition to the production of professional separate analyses by department employees, the Fraunhofer INT charges external experts with the initiation, control, coordination and evaluation of studies and expert opinions to complement this field of activity.

A professional focus, which has existed for a long time in the field of new materials, was expanded by study projects and many publications.
Since the mid '90s, the department is responsible for a permanent column in a materials professional journal, which reports on important materials trends in six articles each year. An important task, which was finished last year, was a project for an industry association, which identifies and evaluates trends in the field of materials.
The continuous analysis of the scientific and technological basics of the general application potential and the defense-relevant implications of nanotechnology has developed into yet another focus of the department's work.

In the field of robotics/unmanned systems, the department examines all aspects concerning the future role of automation especially in the military sector. The reason for such considerations is the ever-growing trend towards unmanned military land, air and sea systems for so-called DDD missions (Dirty, Dull and Dangerous).

In the last few years, the department was able to intensify its work in the field of information and communication technology thanks to a third-party funded project the Fraunhofer INT was charged with by the Bundeswehr IT Office (IT-AmtBw).

The aim is to develop separate expert reports concerning prominent topics as well as to identify current highlights in the field of IT.
Another important work result in this area is a summary of several articles compiled in the last few years by the department in a book publication about IT. This summary, entitled "Informations- und Sensortechnologien im militärischen Bereich", was published in the Fraunhofer INT series "Technologie, Verteidigung und Sicherheit".

A well-established area of specialization of the department's work, which more and more emerges as a dominant scientific/technological key area of the coming decades, encompasses the topics biological technologies and life sciences. Here, the essential task is to detect and analyze all developments, with a focus on biological technologies and systems (e.g. bio sensors, bio materials, bio computers).

Lately, the field of energy technology has emerged as yet another focus of TAV department.
Work in this field essentially profited from the results of a third-party funded project on behalf of the German Parliament, in which the department extensively studied the technological aspects of energy storage systems.
The results of this study will be published in the beginning 2009. Moreover, priority is given especially to questions on the energy supply of mobile systems.

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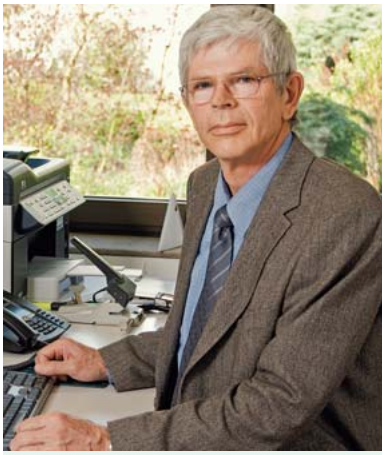

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Meta Analyses and Planning Support (AP)

Meta Analyses and Planning Support (AP)

The AP department supports and advises institutions and companies in planning research and technology (R&T planning) as well as in preparation of concepts and studies relevant to R&T.
This work is done by a team of scientists from various disciplines (physics, geophysics, biology, pharmacy, biochemistry, chemistry, engineering sciences, economics and computer science).

Long-term observation of R&T evolution, expertise in planning processes, methodological knowledge and natural-scientific/technical background knowledge constitute the basis required for the assessment of the technical feasibility of projects and for individual support and advice.
In addition, the department produces in-depth analyses and evaluations on scientific and technological issues, considering economic and political aspects. For this purpose, AP develops and uses application-oriented information systems, taking into account recent scientific findings in knowledge and information management.

The fields of activity of AP department are structured as follows:

- National Research & Technology
- International Research & Technology
- Security Research
- IT and Methodology

National Research & Technology

One of the department's core competences is the expertise to support the German Federal Ministry of Defence (BMVg) in the planning of defense R&T. Here, e.g., AP elaborates proposals how the planning process on national and European level (EDA, European Defense Agency; LoI6 Letter of Intent Framework Agreement) can be shaped and where the focus can be placed in the future. Furthermore, AP identifies and evaluates possible cooperations with other nations.

Thus, in the field of defense R&T, the department has the qualifications in terms of content and methods to competently support the BMVg in determining the national position and placing the focus, taking into account security-political developments both inside the EU and its member states as well as worldwide. This includes, e.g., the collaboration with committees such as the R&T Advisory Council, which advises the Research Commissioner of the BMVg in strategic R&T questions, and the ministerial working group for governmental research.

With the creation of explorative roadmaps, the department has the ability, in terms of both content and methods, to identify long-term innovation potentials of selected technologies. By means of scenario planning, the department creates concepts for various topics.
The current scenario study "Forschung im Bereich Sicherheit und Verteidigung im Jahr 2030" (Security and Defense Research in 2030) gives a long-term prospect of the security and defense-related research landscape in Germany and Europe. The knowledge gained here provides indications for the planning of security-related research, infrastructure and organizations.

International Research & Technology

The AP department continuously monitors and documents the development of various security- and defense-related European organizations and agreements, focusing on relevance for R&T.
This monitoring includes in particular EDA, LoI6 and NATO. The report series on planning, coordination and topical focuses of R&T policies of selected countries initiated in recent years was continued. Here, in particular, AP retrospectively examined the development of the United Kingdom's R&T strategy in the years 1998-2008.

On this basis, the department supports, e.g., the BMVg to perform their national representation in international bodies. Moreover, the detailed knowledge of R&T planning documents of other countries' can be profitably introduced into organization of the national R&T planning process and potential cooperations.

Meta Analyses and Planning Support (AP)

Security Research

In 2007 the EU Commission has established the European Security Research and Innovation Forum (ESRIF) with the task to advise the EU Commission until the end of 2009 on the further formulation of security research on the European level in the 7th Framework Programme 2007-2013, and for the time thereafter on the formulation of a long-term oriented, strategic "Joint Security Research and Innovation Agenda".
Fraunhofer INT is involved in several working groups of ESRIF. AP department particularly supports the German chairman of ESRIF working group 4 "Crisis Management"; cf. the separate project contribution in this annual report.

With the European Security Research Program established in the context of the 7th Framework Program (FP7) 2007-2013, and the national security research program "Research for Civil Security" launched complementarily to it, AP has intensified its activities in this field.

AP department has intensified its activities in this area, when the European Security Research Programme was established within the 7th Framework Program 2007-2013, and the complementary National Security Research Program "Research for Civil Security" was launched.
AP department is a partner of the EU security research project DEMASST (Demonstration Programme Security of Mass Transportation), which is coordinated by FOI (Sweden).

AP contributes to the elaboration of a strategic roadmap (selection of scenarios and establishment of priorities). Furthermore, the AP department is the only German partner of the EU security research project CRESCENDO (Coordination action on risks, evolution of threats and context assessment by an enlarged network for an R&D roadmap). CEA (France) is the coordinator of this follow-up project of the EU projects SeNTRE (Security Network for Technological Research in Europe) and STACCATO (Stakeholder platform for supply chain mapping, market condition analysis and technological opportunities). The AP department will contribute to an R&D roadmap and with conclusions and recommendations to the final report.

For a number of years, Fraunhofer INT has worked theoretically on the problems of nuclear weapons to provide expertise on this topic. Due to the global development in security politics, this topic remains relevant for Germany. To independently assess the potential and risks of the use of so-called bunker breaking weapon systems, Fraunhofer INT carries out an evaluation of open literature and own calculations on the basis of physical models.

Moreover, the AP department supports the Advisory Board for Civil Protection to the German Interior Minister (Schutzkommission) and has a leading role there in the development of a system to assess the risk potential of chemical weapons and toxic industrial chemicals.
Based on this approach, a further system to assess the hazards of biological weapons is currently being developed.

For many years, Fraunhofer INT has surveyed the Extended Air Defense (EAD) program.
The work focuses on the observation of relevant activities (US National Missile Defense Program, NATO Integrated Air Defense) and on the support of BMVg in national working groups and on the technological evaluation of EAD. In the view of future NATO decisions on Missile Defense, the technological maturity of the US systems plays a major role and is currently examined. Moreover, the impact of the deployment of missile defense systems in Poland is considered.

The equipment and military capabilities of the armed forces must be regularly adapted to changing security risks. A preliminary study has been carried out, whether the risk of climate change, mentioned in the recent update of the European Security Strategy, could have an impact on operational scenarios. National and international investigations on "Climate change and its impact on international security" have been analyzed and evaluated to ensure a national long-term competence to provide judgment and advice on suitable equipment for the armed forces. It becomes apparent that, next to national decision-making bodies, also EDA and NATO bodies will face an increasing demand for advice and decision-making on these questions in the coming years.

IT and Methodology

In this field, methods for acquisition, accumulation and presentation of information become ever more important. Particularly when presenting complex information, a knowledge representation which describes the relation between information units besides the information itself, is essential. Therefore, together with experts specialized in the particular fields, tailored information systems and knowledge bases are being developed.

Methods for an automatic extraction of relevant text information from the flood of information and its classification according to the content are being developed on the basis of previous work on information systems. This approach leads to effective filtering and serves to enrich information systems with highly relevant information, in order to support decision-makers to find the appropriate decision. This work includes the development of concepts and programs for database, programming of interfaces and in-house systems development.

Moreover, bibliometric topics are covered. Specifically, a bibliometric survey of institutes and countries is carried out as well as an analysis of trends and conclusions which can be deduced from such surveys. New methods and indicators are checked for their robustness and validity to improve the quality of bibliometric investigations.

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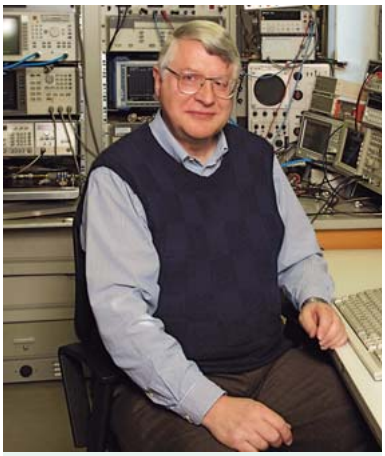

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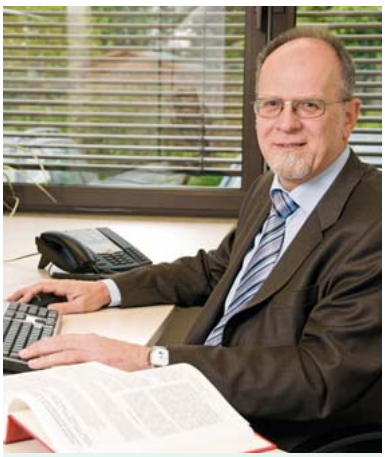

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Nuclear and Electromagnetic Effects (NE)

Nuclear and Electromagnetic Effects (NE)

In the framework of the base funding provided by the German Federal Ministry of Defence (BMVg), the Nuclear and Electromagnetic Effects (NE) department has the following tasks:

- Maintaining and further developing the national assessment ability in the fields of nuclear weapons, effects of nuclear weapons, radiological weapons and their associated asymmetric threats,
- Making contributions to the development of the assessment ability in the field of electromagnetic effects concerning military threats.

Since the non-military sector does not deal with these tasks at all, and the military sector only does in small subfields, the Fraunhofer INT conducts its own theoretical and experimental research. Basically, there are four working groups:

- Physical-Technological Aspects of Nuclear Security,
- Nuclear Detection Techniques and Security Policy,
- Nuclear Radiation Effects in Electronics, Opto-Electronics and Fiberoptics,
- Electromagnetic Effects.

Until the end of 2008, the working group "Physical-Technological Aspects of Nuclear Security" is located in both the Meta Analyses and Planning Support (AP) department and the Nuclear and Electromagnetic Effects (NE) department.

The groups "Nuclear Detection Techniques" and "Nuclear Radiation Effects in Electronics, Opto-Electronics and Fiberoptics" jointly operate several irradiation facilities:

- 14 MV neutron generators,
- 2.5 MV flash x-ray facility for pulsed x-ray and electron irradiation,
- Co-60 irradiation facilities,
- Proton irradiation site at the cyclotron of the Research Center Jülich,
- Isotope laboratory and isotope storage room.

In addition to the base-funded research, the NE department performs a series of contract research projects for industrial clients (equipment suppliers for the satellite industry, clients from nuclear research and nuclear engineering) and public clients (mainly authorities and organizations with security tasks and large-scale research institutions). Because of the manifold radiation sources and numerous irradiation facilities, radiation protection accounts for a considerable part of the department's activities. However, this ensures the high investments in our irradiation facilities, which are practically unique in Germany in this specific form and would be approved elsewhere only in connection with significant work efforts.

All working groups are supported by a mechanical workshop, which produces most of the mechanical parts of the experimental facilities, and an electronic workshop responsible for production, maintenance and repairs of the experimental electronic equipment.

Working group "Physical-Technological Aspects of Nuclear Security"

This group carries out scientific studies and analyses to maintain the basic national assessment ability in the field of nuclear security risks and to support political decision-making in technological questions on nuclear protection:

- Evaluation of freely available literature in the fields of nuclear weapons, effects of nuclear weapons and developments of nuclear weapons,
- Theoretical-physical research and numerical model simulations on fundamental questions related to nuclear weapons,
- Studies on the identification, assessment and prevention of nuclear threat scenarios.

The group operates a hydrodynamic neutron transport program and develops it further in relation to current security-political questions. Furthermore, one group member is currently working on a PhD thesis on radiation transport and nuclear fusion.

In September 2009, the Fraunhofer INT is to host the 4th symposium on "Nuclear and Radiological Weapons – Technological Assessment Ability and Nuclear Security in Germany".

Nuclear and Electromagnetic Effects (NE)

Working group "Nuclear Detection Techniques and Security Policy"

The group carries out investigations and research in the fields of:

- Nuclear and radiological threat potential,
- Nuclear arms control and proliferation, safeguards,
- Nuclear security research and security policy,
- Nuclear detection techniques.

The working group currently focuses on potential threats caused by radiological weapons (RDD, dirty bombs). It is feared that these might be used in military as well as terrorist and criminal environments. Theoretical and experimental work was done on the possible set-up and early detection (prevention) of such devices.
The working group extensively observed the assumed efforts of threshold and developing countries (e.g. Iran) to develop and build nuclear weapons, as well as disarmament and proliferation activities, taking into account documents and information from the International Atomic Energy Agency (IAEA) and the Technical Secretary for the Verification of the Comprehensive Nuclear Test Ban Treaty (CTBT). Moreover, the group collaborates in the ESARDA WG "Verification Technologies and Methodologies" (VTM).
All this experience and knowledge flows into the national working group "Radiologische Bombe" ("Radiological Bomb"), which, managed by the Fraunhofer INT, issued the assessment report "Bedrohungsanalyse" ("Threat Analysis").

Another focus is on the further development of measurement systems for the search and non-destructive identification of nuclear weapons as well as fissile and radioactive materials.
In the mobile measurement laboratory cabin NaNu, the entire measurement equipment can be adjusted to the various measurement techniques, so that these can be provided in situ in case of need. A measurement vehicle (station wagon) equipped with large-volume neutron detectors and sensitive gamma detectors can be used in the covert search for fissile and other radioactive materials. The department investigated a new measurement system for neutron detection based on a lithium optical fiber detector on its suitability to detect fast neutrons in a gamma field.
Integrated into a briefcase, the measurement system is for mobile use.

The department created new brief instructions for other measurement systems to ensure swift and faultless operability of the devices even in difficult situations. NE constantly further develops all these measurement systems according to the state of the art in science and technology.
The systems are of great interest not only for the Bundeswehr, but also for national security institutions and Länder authorities.

Due to the knowledge, abilities and equipment in the field of nuclear detection techniques, the working group was also able to realize a series of third-party funded projects, particularly on neutron measurement technology, for public clients from the security sector, industrial companies and the IAEA. For these clients, the working group realized a project for the qualification of safeguard systems for use in nuclear radiation fields, as exist e.g. in nuclear reactors.

Moreover, it successfully participated in a tender of the European Commission for the TACIS program (Technical Assistance to the Commonwealth of Independent States). The Fraunhofer INT is the consortium leader of this project, which develops and implements metrological activities for the Ukrainian border security with regard to smuggling of radioactive and nuclear material.

Working group "Nuclear Radiation Effects in Electronics, Opto-Electronics and Fiberoptics"

In the framework of the base-funded activities, the working group continuously maintains and expands the ability to assess and advise on the susceptibility of satellites electronic equipment to nuclear radiation, and on collateral damage caused by nuclear missile defense systems.

The working group considerably expanded research on the effects of ionizing radiation on electronic circuits, executing a growing number of orders from German companies, mainly equipment suppliers for the satellite industry and nuclear engineering firms. For this purpose, the working group carried out investigations on

electronic, opto-electronic and optical components and systems. These investigations were performed at the irradiation facilities of the Fraunhofer INT, and at a proton irradiation site established by the Fraunhofer INT at the cyclotron of Research Center Jülich. Furthermore, measurement equipment was built for the investigation of neutron-induced single-event effects in microelectronic components irradiated at the Fraunhofer INT's neutron generator and used in the context of research contracts.

The investigation of single-event effects caused by irradiation with relativistic heavy ions was established as a new area of research. In this context, a project funded by the European Space Agency (ESA) was launched for the installation of a novel irradiation site at the Helmholtz Center for Heavy Ion Research (GSI) in Darmstadt.

In the field of fiberoptic radiation sensor technology, the working group improved systems already installed at European accelerators, thus distinctly increasing their reliability in routine operation. Moreover, new sensor techniques using fiber Bragg gratings were investigated for use in radioactive environments. On the one hand, fiber Bragg gratings can detect e. g. temperature and tensile strength as in conventional applications, requiring a selection in which the accompanying irradiation does not lead to mismeasurements. On the other hand, highly radiation-sensitive systems can serve as radiation monitors.

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Working group "Electromagnetic Effects"

In consultation with the German Federal Ministry of Defence (Rü IV2), the NE department's experimental research on electromagnetic threats (particularly HPM threats) is partly coordinated by the "Virtual Competence Center EME of the Bundeswehr (VCC-EME)". The working group

performs fundamental research on the susceptibility of electronic equipment to HPM and other high-intensity electromagnetic fields, on simulation and measurement technology in these fields, and on coupling electromagnetic fields (e.g. HPM) into structures and concrete systems.
Here, basic circuit techniques and component families as well as effects in concrete devices and systems are taken into account.

Currently, a central task of the working group is to investigate the susceptibility of IT devices and systems to EME on the basis of current technology, particularly wire-bound and wireless data transmission technology (network technology).

The working group introduced the principle of a mode-stirred chamber (MSC) as a new measurement technique to achieve very high field strengths and include all directions of arrival.
It performed extensive test measurements in the newly installed chamber at the WTD 81 (Bundeswehr Technical Center for Information Technology and Electronics) in Greding, and established and started operating its own smaller MSC for a frequency range of 0.6 to 18 GHz at the Fraunhofer INT. This allows the exploration of fundamental metrological problems, and investigations on relatively small electronic components up to the high GHz range.

What is more, the Fraunhofer INT operates a self-developed TEM waveguide field simulation facility in a shielded hall for a range of 1 MHz to 8 GHz.
The facility allows linear coupling measurements for the determination of transfer functions, and interference measurements with constant and pulsed fields with field strenghts of up to several kV/m on objects with a volume of up to several m^3.
For measurements outside the institute, e.g. in the EMC hall of WTD 81 in Greding or at airports, the Fraunhofer INT possesses a self-developed mobile HPM irradiation facility, which, by means of horn antennas, generates field strenghts of up to 5 kV/m within a frequency range of 450 MHz to 4 GHz. The facility is integrated into a Bundeswehr telecommunications shelter and can be transported by truck to the measuring site.

Furthermore, the Fraunhofer INT has a small absorber room for radiation experiments up to 40 GHz, and comprehensive high-frequency and microwave measurement equipment.

Moreover, the department carries out numerical coupling investigations and creates theoretical studies on NEMP and HPM threat scenarios, the HPM source development and specific questions from the BMVg and its operational area.
The working group continued its participation in the NATO study group "NATO RTO SCI-198 Task Group Protection of Military Networks Against High Power Microwave Attacks".
Furthermore, one Fraunhofer INT employee of the EME working group is member of the ESRIF WG 2 "Security of Critical Infrastructures".

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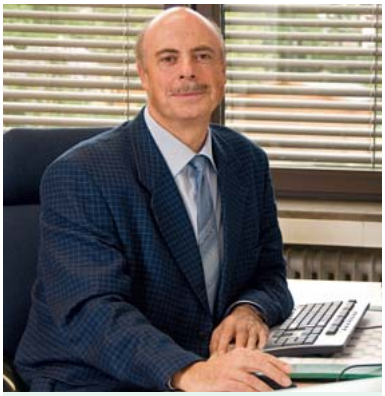

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Business Administration (BZD)

The Business Administration department performs all commercial and administrative tasks and provides the Instititute's central infrastructure. The department comprises the following functional areas:

Finance and Accounting, Purchasing

This area carries out the Institute's book-keeping according to the German commercial and fiscal law. On-going transactions are booked simultaneously in finance accounting and costing to make costs available for both internal accounting and controlling. Additionally, the area handles the purchase of all consumer items and investment goods in compliance with purchase guidelines, the German Official Contracting Terms for Award of Service Performance Contracts (VOL) and the German Construction Contract Procedures (VOB). In cooperation with the headquarters, the department invites Europe-wide tenders for major acquisitions. Furthermore, the area administrates the Institute's cash office and handles all cash and non-cash payment transactions.

Controlling and Project Administration, Auditing

The task of this area is to control all monetarily relevant processes in the Institute. This includes the supervision and control of the Institute's entire budget. To handle this task, the department evaluates cost and activity accounting as well as financial accounting, and generates monthly control data, which includes projections on a cost and payment basis. Furthermore, the area administratively supports the other departments' work. This includes a.o. assistance in creating quotations and filing applications,

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calculation, conclusion of contracts and supervision of the project budget. Since sponsors continuously audit the institute internally and externally, the department deals with all requests of audit organs.

Human Resources

Human resources supports the institutional administration in personnel planning and handles all personnel-related tasks, such as job advertisements, hiring, job evaluations and resulting classification into salary or wage groups, contract extensions etc. In addition to general administrative tasks, such as documentation of dossiers and personnel data management, HR supports the other departments in selection procedures, the creation of work certificates and other matters. The area also advises the employees on all issues concerning labor and collective bargaining law.

Traveling Management

The traveling management supports Institute members on all issues related with business trips. This includes planning and scheduling, booking of means of transport and accommodation as well as accounting in compliance with the German Federal Traveling Expenses Act.

Facility Management/Internal Services

Among other things, this area registers and initiates necessary repairs, helps to coordinate construction operations, administrates equipment and manages and maintains company vehicles. It also purchases and administrates furnishings and office supplies, organizes cleaning and operates the in-house printing office.
Under the management of the headquarters' building department and in cooperation with the responsible authorities, a master plan for the further development of the real estate was created. This master plan stipulates the construction of a lecture room, an office building and a library and archive building.

Marketing and Public Relations

This functional area supports the marketing of the Institute's work, providing print media such as annual reports and brochures about the Institute. It also manages press relations and the presentation of the Institute at symposiums, exhibitions and other events as well as other supportive measures. The area also continuously updates and maintains the Institute's presence on the Internet and on the Intranet of the Bundeswehr.
In 2008 the area actively participated in the creation of the BMVg's R&D annual reports in German and English. To support the scientific departments, the area furthermore examined tenders of national and EU authorities for project opportunities.

Library and Specialized Information Services

This area focuses on providing and maintaining the media necessary for the Institute's work and supporting the scientists in research and information obtainment. Furthermore, the area accompanies the publication processes of the Institute. In addition to several articles in magazines, conference contributions and reports, two books were published in 2008.

Central IT Services

Central IT services operates the entire IT infrastructure of the Institute and provides technical user support. In 2008 the efficiency and operating safety of the IT equipment was increased by a series of technological improvements.
The area a.o. successfully set into operation a central software deployment system, established a more efficient spam quarantine in collaboration with the Network Operations Center (NOC), realized a new storage cluster solution and implemented the PKI v2 (Public Key Infrastructure).

By these measures and several others which cannot all be mentioned in this report, the BZD department was able to substantially improve the framework conditions for the Institute's work. In doing so, the department set the preconditions for further successful research.

Selected developments in materials research

Selected work results

Selected developments in materials research

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The observation of developments in materials research is a major task of the TAV department's technology monitoring. Due to the wide-ranging spectrum of this realm, its heterogeneity, and the constantly rising industrial demand for the development of materials with new properties as well as for accessing new fields of application, a variety of different trends can be identified. There is continuous progress e.g. in the improvement of different characteristics in all material classes, in multi-scale modeling and simulation of materials and their behavior under strain, and in novel nature-inspired synthesis methods.
The increasing pervasiveness and differentiation of smart materials in applications should also be mentioned here. In addition to this, genuine breakthroughs are time and again achieved in materials research.

Since recently, there exist two new material classes whose realization had not even been imaginable for a long time: the so-called metamaterials, which feature negative refractive indices, and graphene, a purely two-dimensional materials configuration of free single-layer carbon sheets.

Metamaterials

Metamaterials (from Greek méta = after, beyond, with) are artificial materials in which specially formed technical components are assembled in a three-dimensional periodical structure analogous to a crystal lattice, so that the individual components can be considered "artificial atoms".
They interact, as a homogeneous medium, with waves whose wavelengths are substantially larger than the metamaterials' internal structure.
The interacting waves can e.g. be electromagnetic radiation (such as light) or sound waves.
Metamaterials with new properties that do not occur in nature were already discussed in theory some decades ago.

Their characteristic is "left-handed" behavior, i.e. they feature negative refractive indices. Since a few years, they can also be produced.

The components of electromagnetic metamaterials mostly consist of metallically conductive materials which are supported by non-conductive material. Their shapes range from wires, non-closed rings, rolled-up multilayers to comb structures, coated spheres and multilayer systems with regular holes.

The size of the respective artificial structures determines the wavelength range in which metamaterials work. Experiments initially were conducted with microwaves, corresponding to structures in the millimeter range.
By now, research has advanced over the terahertz and infrared radiation range to the threshold of the visible spectral range. This required the nanotechnological realization of extremely small, well-defined structures.

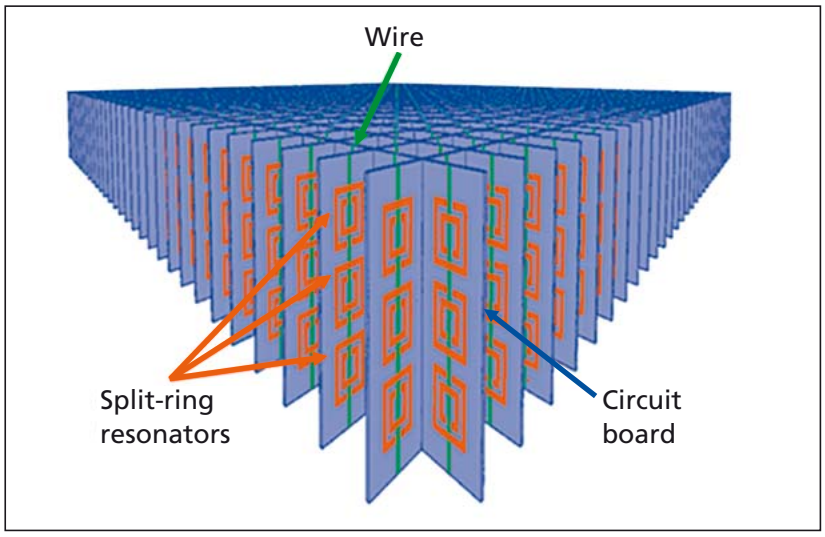

Fig. 1: Example of the structure of a metamaterial (Source: NASA)

With the selection of materials and structures that form the artificial atoms of metamaterials, it is possible to build arrays with a negative refractive index in a defined wavelength range. In contrast, the refractive indices of all natural materials are positive numbers. Materials with negative refractive indices behave surprisingly. When entering such a material, light is refracted in a different direction than usual, so that e. g. concave lenses concentrate light and convex lenses disperse it. A spoon dipped into a cup filled with a liquid of negative refractive index would appear as if its lower part sticked out of the liquid again.

Metamaterials with tailored refractive indices allow the conception and realization of a series of new applications. For instance, highest-resolution

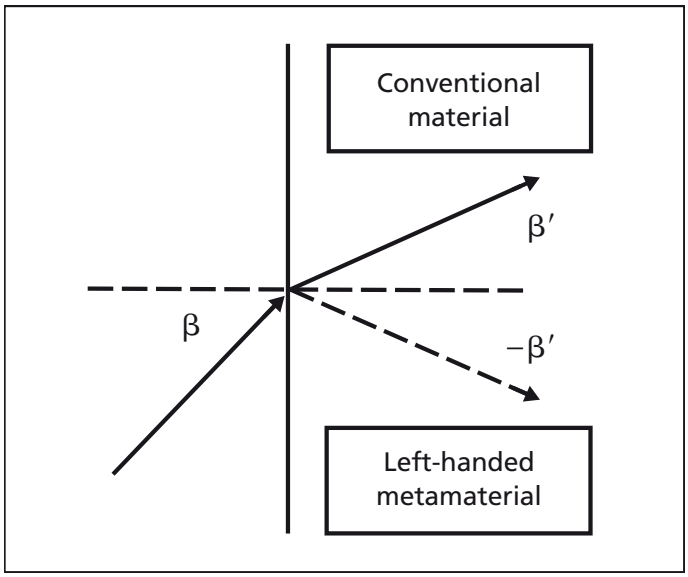

Fig. 2: Schematic view of left-handed refractive behavior

superlenses can be constructed which exceed the natural limits of conventional optics.
They could push forward optical microscopy, but also optical lithography, which is used for the production of microelectronic components, down to the nanometer range, and could allow for optical storage media with substantially higher storage densities.

On the basis of the same principle, a perfect cloaking device can be realized which bends the radiation around an object, so that it can no longer be "seen" in a narrow wavelength range.

The functional principle has already been demonstrated with microwaves. In the fields of communication and radio engineering, metamaterials are already on the verge of being applied in practice.

Graphene

Pure carbon comes in a variety of molecular and crystal forms with very different properties. Established carbon modifications include diamond, graphite, amorphous carbon, fullerenes and carbon nanotubes. A purely two-dimensional carbon variety consisting of one atomic layer, so-called graphene, was on principle considered unable to exist for a long time.
Since 2004, however, this carbon form can be constructed. This opened up a new material class of two-dimensional materials, which allows the investigation of fundamental, very exotic and so far hardly accessible physical phenomena.
Above all, graphene features outstanding properties, some of which already promise versatile applications in the near future.

Graphene consists of carbon atoms hexagonally arrayed in a plane (honeycomb-like structure). Its electronic and mechanical properties are of special interest. For instance, its charge carrier mobility, which defines both electrical conductivity and switching speed of electronic components, exceeds at room temperature that of all known materials by orders of magnitude. Since its conductivity changes substantially by the adsorption of molecules, graphene also allows the realization of sensors for the detection of individual molecules. Moreover, its high conductivity causes a high absorption capacity for light, so that already one atomic layer of graphene can be clearly seen under a light microscope.

The most promising field for applications is electronics. For instance, due to their high electrical and thermal conductivity and their low noise level, graphene nanobands are candidates to replace copper as conductive material in integrated circuits. Structured graphene bands render possible tiny, precise and robust field-effect transistors with very high switching frequencies. A promising component is the single electron

transistor, which is very small, fast and energy-efficient. It is based on nanophysical effects and has already been realized without graphene. Also here, graphene shows unique advantages, e. g. reliable operability at room temperature. Moreover, graphene unlocks completely new opportunities for spintronic applications, which not only exploit the charge, but also the electron spin for information processing.
It may be the ideal material for the realization of nanotechnological quantum computers.

One of the remarkable mechanical properties of graphene is its outstanding hardness which even exceeds that of diamond. At the same time, its molecular sheets are elastic and flexible.
Their Young's modulus is as high as that of high-performance ceramics, and their tensile strength

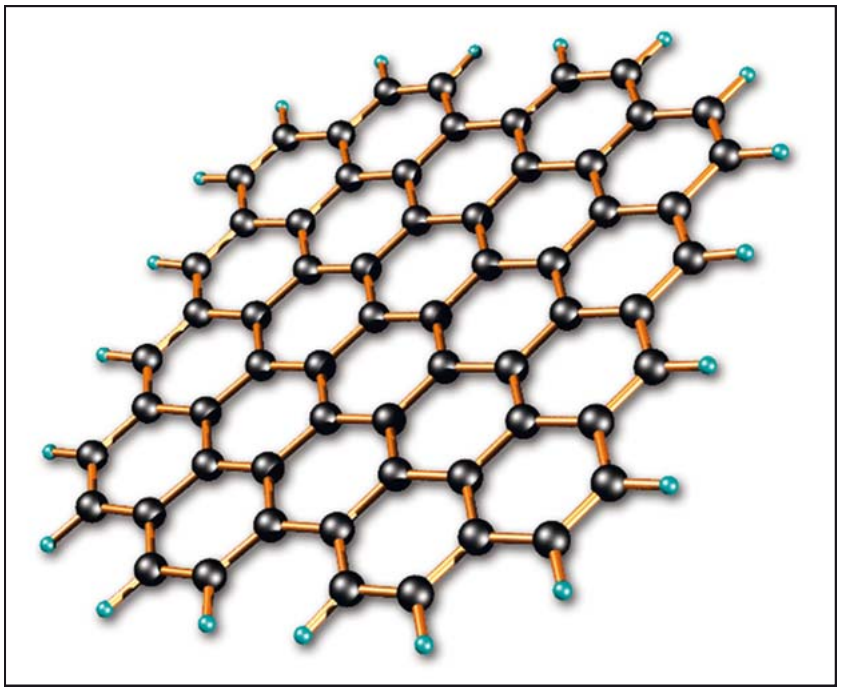

Fig. 3: Example of a graphene sheet
(Source: Lawrence Berkeley National Lab)

is second only to that of carbon nanotubes.
Its thermal conductivity more than doubles that of the previous record holder diamond. Due to its large surface, graphene may also serve as a suitable material for hydrogen storage systems and supercapacitors.
Graphene layers are extremely chemically stable, e. g. against acids and bases, so that they may be used as transparent chemical protective layers.

Complex systems

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The TAV department has identified the increasing complexity of technological systems as an important and long-term mega-trend.
Problems resulting from this development came to public attention e.g. when Thomas Enders, CEO of EADS, announced another delay in the delivery schedule of the new Airbus A380, currently the largest aircraft in the world, in May 2008. His justification was that they "had underestimated the complexity of the problem".
In total, the delivery of the first Airbus A380 to Singapore Airlines was delayed for more than a year. The financial damage resulting from this delay amounts to several billion euros.
It is not the first time that a company or an organization has underestimated the complexity of technological innovations. Another example is the introduction of the German Toll Collect System for truck toll collection. The delays that occurred there were caused by problems with the complex interaction of different technologies and subsystems. In the mid 90's a Standish Group survey estimated the loss for the American industry due to failed complex software projects at approximately 81 billion euros only in 1995.

An analysis of the A380 case shows that the highly networked development and production process was substantially disrupted at a certain critical point. In addition to interconnectedness, this potential dependency on some few critical nodes within the whole system is one of the characteristics of complex systems.

However, it is difficult to present a general definition of what a complex system is.
Among other things, this is due to the fact that the science of complex systems is neither methodically nor thematically a clearly defined field.
It covers a multitude of partly very different systems, from pattern formation in chemical and biological systems far from the thermodynamic equilibrium to the analysis, development and verification of complex technological systems and even to issues concerning social and economic developments. For this, scientists not only use methods from mathematics, physics (especially statistical physics), chemistry and computer science but also from sociology and economy.

In this sense, the currently emerging science of complex systems is not a self-contained theory which would replace or improve an already existing theory. It is rather a kind of meta-principle: a sort of general approach which is useful for creating and evaluating new research hypotheses. Mostly, these concepts are rather used in a catalytic manner, as thought-provoking impulses and sources of ideas, than being integrated into a completely formulated theory.

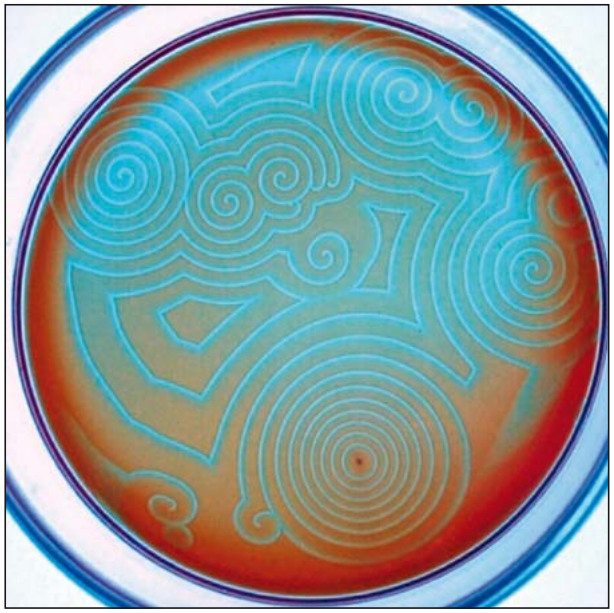

Fig. 4: Pattern formation by self-organization in a complex chemical reaction system using the example of the Belousov-Zhabotinsky reaction (Source: Universität Magdeburg).

Although there is at present no common definition for the term "complex systems", some key characteristics of complex systems can be identified and explained.
The most striking feature of complex systems is the great number of parts they consist of.

These parts, in turn, can also constitute (much less complex) systems. The great particle number leads to a great number of possible states of the whole system. But this alone does not suffice to turn large systems into complex ones.
This becomes apparent, when observing a container filled with gas which contains an extremely great number of particles (in the order of magnitude 1026). However, the container is not regarded as a complex system. The difference emerges from the way in which particles interact. In the case of the simple gas, the interactions between atoms or molecules have a very short range and are thus practically irrelevant.

Complex systems, on the other hand, are characterized by non-linear long-range interactions between their individual components. These interactions lead to a high interconnectedness among the parts, i. e. (almost) every part interacts with (almost) every other part. In the case of the gas container, it is only required to measure pressure and temperature to obtain a general description of the whole system which is sufficient (for most applications). In contrast, complex systems elude such reducing approaches.

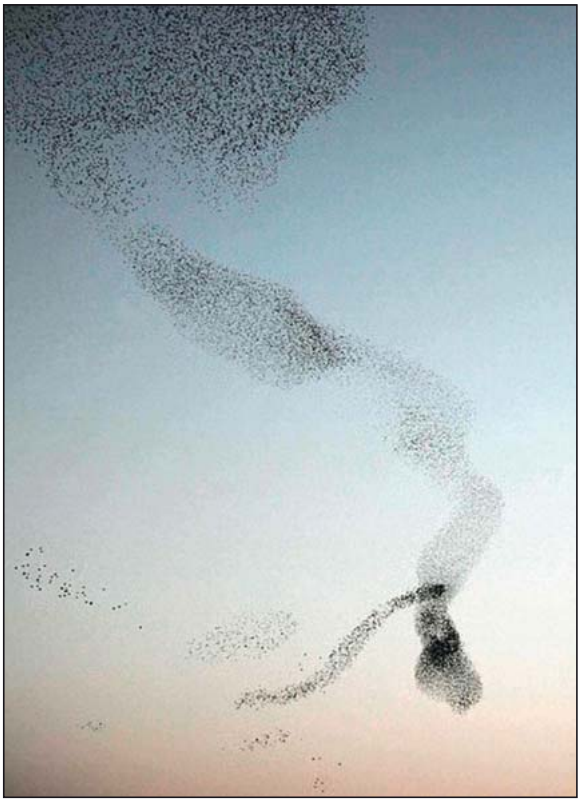

Fig. 5: The swarm behavior of animals (here a flock of starlings) is a typical example of emergence. Since the swarm seems to act intelligently as a whole, this phenomenon is called swarm intelligence. The swarm shows behaviors of which its individual members are not capable (Source: STARFLAG project, INFM-CNR).

This is due to feedback effects resulting from the above mentioned profound interconnectedness within the system. These feedbacks are responsible for small disturbances that can build up in the system either in a constructive way, i. e. new structures emerge, or in a destructive way, i. e. the system's functionality is compromised.

The above discussed characteristics of complex systems (interconnectedness and feedbacks) are generally held responsible for the fact that complex systems can display emergence.
This concept is best summarized by the well-known saying "the whole is more than the sum of its parts". Due to a process of self-organization, whose details are subject to current research, complex systems develop entirely new characteristics on a macroscopic level. The (microscopic) parts (or subsystems) neither feature these characteristics, nor can these characteristics be derived from these parts. On the technological level, this phenomenon can be simulated and experimentally used, e. g. in the field of robotics.

The science of complex systems is still in its infancy but will gain importance in the future as technological and social systems become more and more complex. During the last decades, this explosion of complexity ignited and advanced especially by progress in the fields of transport, communication and information technology. These three technology fields lead to a stronger interconnectedness of technologies and systems as well as long-range non-linear interactions and feedback loops between and within the systems. These elements are central characteristics of complex systems.

This underlines the fact that the science of complex systems will play an important role in the future. Regarding future technological applications and trends, two different aspects, which will profit from this new field, can be identified:

- An important part of the science of complex systems is their analysis. In the future it will thus be possible to verify the correct functionality of complex technological systems.

This aspect is especially important in the field of safety-critical components in traffic engineering.

- Since complex systems more or less elude a reducing analysis, which divides an issue into smaller and thus better manageable sub-issues, new demands will be placed on the development process of complex systems. The process itself is also a complex system and has to be organized accordingly in order to prevent failures such as described above or at least contain their effects.

By means of interdisciplinary approaches, science and technology are expected to gain a better and more accurate understanding of the details and functionality of complex systems and their design principles in the future. Since the human brain itself is an extremely complex system, man will also learn a lot about himself. As yet, it is impossible to foresee the impacts this might have on the image of man in particular and on society in general.

ESRIF – European Security Research and Innovation Forum: Strategic Research Planning on European Level

ESRIF – European Security Research and Innovation Forum: Strategic Research Planning on European Level
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Background

The European Security Research and Innovation Forum (ESRIF), established by the European Commission in 2007, shall advise the Commission on how to further shape security research on European level in the later stages of the 7th framework programme (FP7) 2007-2013 and beyond. Research recommendations will be provided as a long-term oriented, strategic "Joint Security Research and Innovation Agenda" until the end of 2009 (cf. COM (2007) 511 from 11 September 2007).

ESRIF as an advisory board of the Commission is the successor of ESRAB (European Security Research Advisory Board), which developed and delivered in 2005-2006 recommendations for the design of the European Security Research Program within FP7.
Fraunhofer INT participated in several working groups in ESRAB as well as it is engaged now in ESRIF. The AP department supports in particular the German chairman of ESRIF WG4 "Crisis Management", so, this article is mainly based on insights which were generated by this supporting activity.

Scope and Work Approach

It is the task of ESRIF to draw conclusions and recommendations in particular on the long-term strategic focus and scope of future European security research within the framework of a "Joint Security Research and Innovation Agenda". For that purpose, it is important:

- to improve and foster the dialogue between public and private sector, between supply side and demand side in the area of security research and innovation (public-private dialogue),
- to foster innovative ideas, to improve the global competitiveness of European industries and to prepare the ground for the development of international cooperation in the field of civil security,
- to analyze the future need for security capabilities, by taking into account current and already foreseeable future threats.

In order to deepen this dialogue, which started with ESRAB, EU Member States, FP7 associated countries (Croatia, FYROM, Iceland, Israel, Liechtenstein, Norway, Serbia, Switzerland and Turkey), the EU Commission itself and European Agencies (like e.g. EDA, European Defence Agency) delegated 63 representatives from the demand side (i.e. public authorities and private end users of security technologies), the supply side (industry and research) and the civil society (e.g. European Parliament and non-governmental organizations) to ESRIF. There, Germany is represented by five members.

ESRIF established an appropriate working structure with eleven working groups, in order to cope with its complex and forward-looking task. These working groups, headed by ESRIF members, incorporate more than 600 experts coming from throughout Europe that have been recommended and accepted by ESRIF members. These eleven working groups cooperate in a matrix approach, which at its core is pre-set by the thematic structure of the FP7 security research program (mission-oriented working groups vs. cross-cutting, technology-oriented working groups).

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However, due to ESRIF's more comprehensive and in particular strategic scope, considerable amendments in further thematic areas like "Foresight and Scenarios", "Innovation" and "Human and Societal Dynamics of Security" were made.
The challenges and requirements ESRIF faces are manifold. Security and security research have to be planned and designed to cope with a complex and continuously changing environment that is influenced by various factors on different levels.

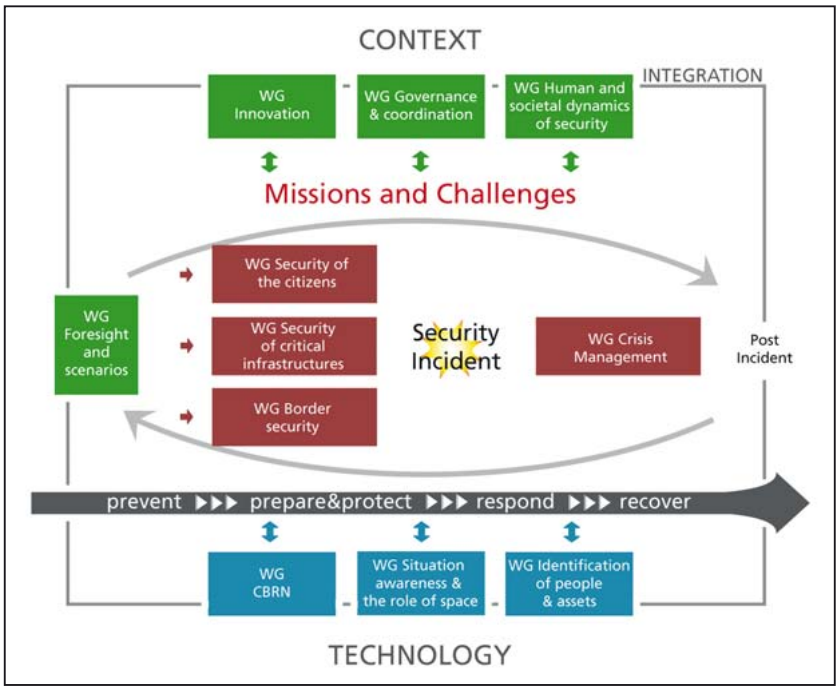

Fig. 6: Working structure of ESRIF
(Source: ESRIF Intermediate Report, Brussels, September 2008)

The consequential multi-dimensionality of this system as well as following multi-dependencies has to be addressed in a comprehensive way, which is a challenging task for any kind of a forum of volunteers like ESRIF. Important factors and aspects, to be taken into account by any recommendation of ESRIF, are (non-exhaustive):

- Changing threats in the long-term perspective, e.g. as the result of climate change in terms of related availability of vital natural resources like drinking water, food and energy,
- Growing of global dependencies (e.g. the financial system) and changes in global political power structure (future role of important countries outside Europe, like US, Russia, China, India among others, but also non-governmental actors),
- Global trends in technological developments versus societal acceptance and protection of individual liberty rights,
- Short-term need for security technologies versus long-term, in its effects barely foreseeable changes in individual and societal security environment (dealing with uncertainty),
- Horizontal (individual, local, regional, national, trans-boundary, European und Pan-European) and vertical (individuals, public authorities and institutions, industry, science and research, politics, societal groups of any kind) multi-dimensionality of security,
- Handling of radicalisation tendencies inside and outside Europe,
- Complexity of already existing or projected security-related capabilities in EU Member States and on European level (capabilities of public authorities and institutions, industrial range of products, ongoing research or research results that are already available, but not yet implemented in products/applications/capabilities, etc.),
- Legal and other norms, standards and regulations,
- Questions of future role allocation between EU, its Member States and its populations,
- Future arrangement of defense and civil security,
- Questions of an "optimal" relation of preventive and protective measures compared to appropriate measures for the improvement of the resilience of our society and its critical infrastructures,
- Necessary coherence of security policies, security-related capabilities and security research (technical and non-technical), etc.

Scientific interest and Perspective

The scientific interest of the AP department in working with ESRIF is bi-directional: being established in and, thus, influenced by methodical thinking of the defense sector, the intensive collaboration in ESRIF reveals – beside certain differences – a set of similarities between requirements in strategic security research planning and those in the defense sector. While the differences are obvious (e.g. regarding the different budgets of the respective public authorities and the

different "customer profiles" in the respective markets), our interests are related to a more detailed consideration and analysis of potential similarities to be identified for the mutual benefit of defense and civil security.
This comprises in particular similarities concerning:

- the orientation of research planning on capabilities (i. e. capabilities-based planning),
- research methods in terms of an "optimal" interaction of capability needs (demand pull) und technology push,
- the existing (national) fragmentation of markets, on the demand side as well as on the supply side,
- the need to prospectively overcome this fragmentation in an appropriate way, e. g. in terms of harmonisation of capability requirements, in terms of European standards and norms as well as in terms of joint training and exercises etc.

Bi-directional against this background means that the AP department on the one hand contributes to ESRIF, wherever appropriate and welcomed, by bringing in suggestions and experiences from defense-related research planning. On the other hand, however, ESRIF holds the opportunity to observe and analyse how, compared to the defense sector, challenges for strategic research planning on European level in the area of civil security are tackled differently.
This, in turn, helps to derive new perspectives and ideas for strategic research in the defense sector and goes along with the proceeding convergence of security and defense research – a process in which the AP department wants to continue taking an active part.

Measuring ionizing radiation by means of a fiber Bragg grating

Measuring ionizing radiation by means of a fiber Bragg grating

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Introduction

By now, the use of optical fibers to measure ionizing radiation in particle accelerators is an established sensor technology which was mainly developed here at the Fraunhofer INT.

In optical fibers, ionizing radiation creates a range of effects which can be utilized in sensor technology:
The best known effect is the increasing opacity of the fibers. Especially in fibers doped with germanium and co-doped with phosphorus, this effect has very advantageous properties for the dosimetry: the radiation-induced attenuation is very strong, follows the dose linearly and is independent from the dose rate. Additionally, the induced attenuation shows only low annealing (fading) after the irradiation. These properties, however, are only effective up to a dose of 10^3 Gy (SiO_2). From about 10^4 Gy (SiO_2), the induced attenuation goes to saturation.

Another known effect is the creation of Cherenkov radiation. It is emitted by particles that move faster than the speed of light in a medium. If light is emitted in the right angle to the optical fiber it can be transported by it to the detectors. The delay allows for the detection of the radiation's point of impact.
The Fraunhofer INT developed systems based on both effects for the application in Free Electron Laser (FEL) facilities at the German Electron Synchrotron (DESY). These were described in the annual reports of 2001/2002 and 2003/2004. Since then, improved versions of these systems have been installed in other FEL facilities in Europe.
Another effect of ionizing radiation in glass is the change of the refractive index. Since the refractive index does not go to saturation until higher doses are reached, there is hope that dosimetry can be conducted in high dose environments (10^5 to 10^7 Gy(SiO_2)) by means of this effect.

Fiber Bragg Gratings

A common technical method to measure the refractive index is to use so-called fiber Bragg gratings (FBG). If an optical fiber doped with one of the elements Ge, B, Ce, N, Sn or Sb is irradiated from the side with UV light, it is possible to inscribe a periodical structure. Thus, a one-dimensional diffraction grating, an FBG is created (see Fig. 7).
If light of a specific wavelength hits the FBG, it is backscattered because of interference at the FBG (reflection). Accordingly, in transmission

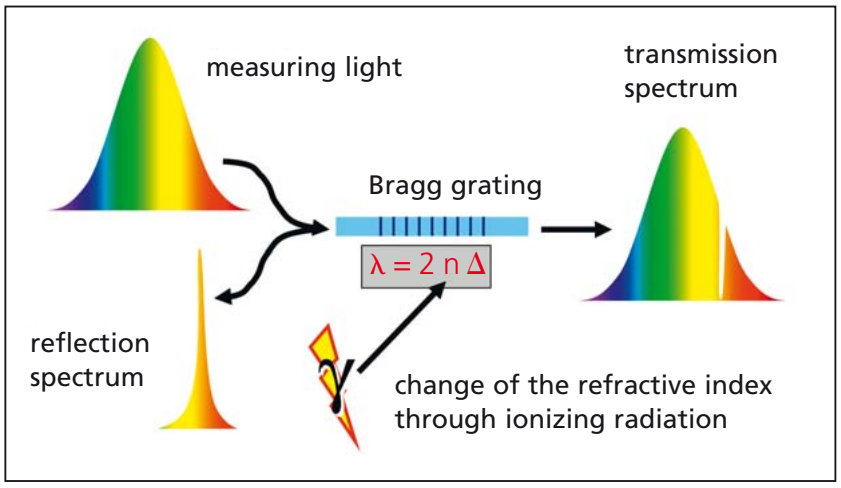


Fig. 7: Functionality of a fiber Bragg grating (FBG).

this leads to a gap in this part of the coupled-in measuring light. The formula for this Bragg-wavelength is: $\lambda = 2\ n\ \Delta$, with Δ describing the distance of the grating elements and n the refractive index. Should the refractive index at the grating change through the influence of ionizing radiation, λ changes too. This change can be measured by sensitive spectrometers.

Measuring ionizing radiation by means of a fiber Bragg grating

Choice of Fibers and Production Parameters

As with the other systems, an FBG-system also necessitates an optimal choice of production parameters. The Fraunhofer INT was able to build on its decade-long experience in the field of induced attenuation as well as on the comprehensive presentation in specialist literature.

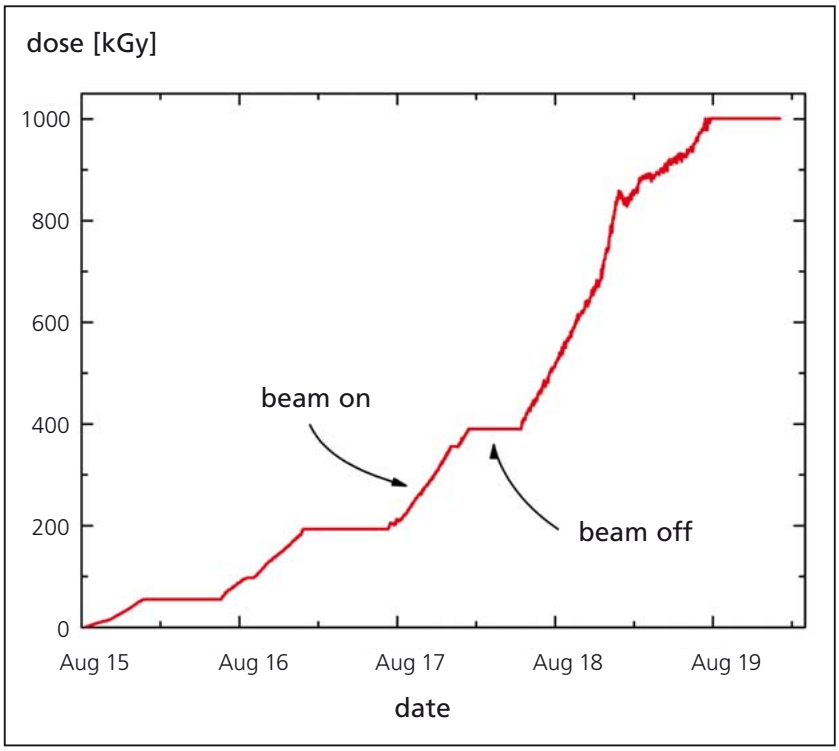


Fig. 8: FLASH measuring results

FBGs, however, are a relatively young invention. In literature, presentations of the effects of ionizing radiation are thus incomplete and partially contradictory.

For this reason, the Fraunhofer INT conducted an extensive comparative test. 12 fibers with partly very different compositions were chosen.

The fibers contained Ge in concentrations of 4 mol% to 24 mol% as well as P, Al, Ce, F or B. Since the producers to some extent did not provide satisfactory information on the composition, it was necessary to ascertain it with an Electron Probe Microanalysis (EPMA) which was carried out by the Fraunhofer IST. Under identical conditions a German producer inscribed Bragg gratings in these fibers.

The results of the following irradiation tests were surprising. In induced attenuation, the fiber composition lead to differences of several orders of magnitude, whereas differences in the shift of the Bragg-wavelength after a dose of 10^5 Gy(SiO^2) were only a factor of three. In addition a systematic dependence on the composition and the induced attenuation of the used fiber could not be identified.

In a next step, gratings with different production parameters were inscribed in the fibers that provided the most sensitive gratings. These parameters include the loading of the fiber with hydrogen, the energy of the writing laser and the temperature during the stabilization of the grating. The hydrogen loading increases sensitivity, but the energy of the writing laser has no influence whatsoever. There is an optimal temperature for the stabilization of the grating. Any further temperature increase will have no significant effect on the sensitivity.

First tests at FLASH and Outlook

To gain experience with the new sensor system outside the controlled laboratory environment, a first test measurement was carried out at the FLASH facility at the DESY.

At the FLASH (formerly VUV-FEL), electrons accelerated to 1 GeV in a linear accelerator generate coherent light of wavelengths of up to 6 nm with highest brilliance in subsequently arranged undulators. For years, the fiber optic systems mentioned in the introduction have been used successfully in FLASH to monitor radiation levels and to protect the susceptible undulators. In addition to its use in current research, FLASH also serves as a test system for the planned European x-ray laser facility XFEL. In this facility, electrons accelerated to 17.5 GeV generate coherent light of wavelengths of up to 0.1 nm in a ca. 1.5 km long undulator structure.

Together with experts from DESY, an area with high radiation exposure was identified for the tests. Those gratings that were previously identified as the most sensitive ones were irradiated with ^{60}Co up to a dose of 10^6 Gy at

the Fraunhofer INT. The measured Bragg-shift serves as a calibration curve for the FLASH tests. Fig. 8 shows the FLASH measuring results: within only four days a dose of 10^6 Gy was reached. This was an unexpected result for the experts, since they never before had had the possibility to carry out an online radiation measurement in this area. After this first promising demonstration, it will be necessary to develop a system from the test set-up geared to the requirements of DESY. Due to its length, especially XFEL will present challenges to the operability and maintainability of the dosimetry systems.

Additionally, it is examined if new developments provide a clear improvement over conventional UV-Bragg gratings. However, there is no knowledge yet regarding these new developments (such as fs-Bragg gratings and chiral Bragg gratings) and their behavior towards ionizing radiation.

Visit of the Minister of the Interior of North Rhine Westphalia Dr. Ingo Wolf on 30 April 2008

On the occasion of his visit to the Fraunhofer INT on 30 April 2008, the North Rhine Westphalian minister of the interior Dr. Ingo Wolf was impressed by the Institute's manifold task spectrum.

Dr. Wolf, Dr. Wiemken and Dr. Schmidt during a tour around the experimental hall

After being welcomed by the director of the Institute Dr. Wiemken, the minister of the interior spoke with the heads of the departments and informed himself about the latest developments and trends in research and technology.
Afterwards, Dr. Wolf visited the experimental hall, a.o. the simulation facilities for electromagnetic pulses and pulsed microwave radiation, and the wave guide simulator for electromagnetic coupling measurements.
At the same time, Dr. Schmidt explained the applications and functionalities of the facilities.

Future Security 2008: International Security Research Conference

One year after the start of the German and European research programs, scientists, entrepreneurs and politicians presented first results at the security research conference from 10 – 11 September. Patron of this conference is the German Federal Ministry of Education and Research (BMBF). In 2007, the German federal government had initiated a cross-departmental security research program. In the 7th EU research framework program, this key topic came into the focus for the first time.

Dr. Wiemken as chairman during the opening of the session "Security and Space"

This year, the conference again succeeded in fostering cooperation and bringing together national and international actors: speakers and participants from eleven countries used the conference to describe the current state of affairs

Dr. Rosenstock in a professional conversation at the stand of the Fraunhofer INT

and discussed innovative technologies and projects as well as preventive measures for civil security. International speakers included Admiral Jay M. Cohen, Under Secretary of Homeland Security for Science and Technology of the United States Department of Homeland Security, and Dr. Jacqueline Lecourtier, General Director of the French National Research Agency.

Signing of the cooperation agreement between the Bonn-Rhein-Sieg University of Applied Sciences and the Fraunhofer Institute for Technological Trend Analysis INT, Euskirchen

On 8 October 2008, the Fraunhofer Institute for Technological Trend Analysis INT and the Bonn-Rhein-Sieg University of Applied Sciences signed a cooperation agreement.
Target of the agreement is to expand the cooperation between the University and the Institute in the areas of research and teaching.

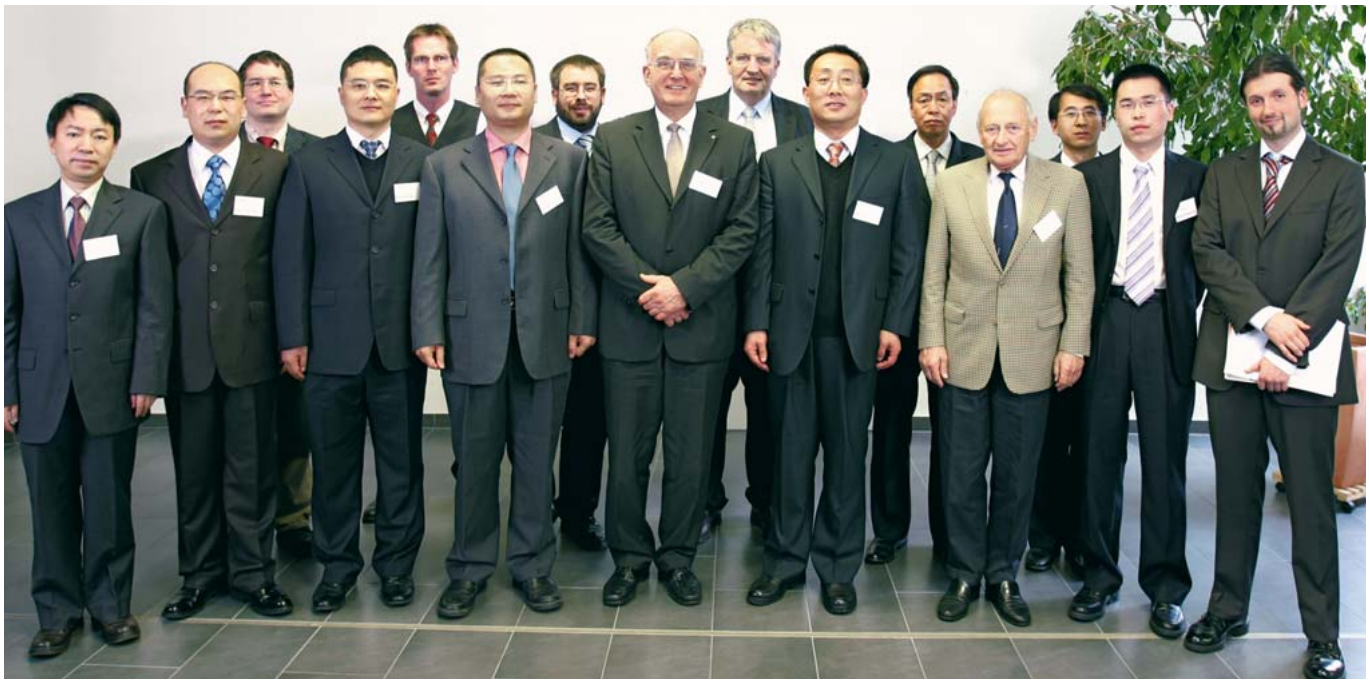
Based on this agreement, scientists of the Institute will give lectures at the University and students will be given the opportunity to write their diploma or master thesis at the Institute.

Moreover, it is planned to conduct joint research projects.

Prof. Dr. Krzeminski, Prof. Dr. Schümchen and Dr. Wiemken during the agreement signing ceremony

Visit of a Chinese delegation from 27 – 29 October 2008

In October 2008, eight representatives of the China Defense Science and Technology Information Centre (CDSTIC) visited the Fraunhofer INT. This three-day event included the topics: methods of technology forecast, international research and technology, information systems and threat analyses.



There was an extensive exchange of information between the delegation and members of the institute. Chosen topics included a.o. disruptive technologies, the future defense-related relevance of nanotechnology, energy storage systems, bibliometrics and European security and defense research.

"Research in the Area of Security and Defense in 2030" – scenario workshop 18 – 19 November 2008, Fraunhofer INT Euskirchen

The aim of the scenario study "Research in the Area of Security and Defense in 2030" was to obtain a perspective of possible future developments in the security and defense related scientific landscape in Germany and Europe.
By means of scenario techniques, different scenarios were created and then compared regarding their impacts on research. However, the study did not aim to predict future developments with a high probability. It merely should present opportunities to give thought-provoking impulses for the planning of security-relevant research, infrastructure and organization.
For this, numerous experts gave their professional input in the framework of a two-day workshop which was realized at the Fraunhofer INT under the guidance of the management consultancy Geschka & Partner.

Three scenarios were chosen for further consideration:

Scenario A: the state as an actor in a prospering economic and technological environment with growing asymmetric threats

Scenario B: the state as an actor in a weak economic and technological environment with a series of natural catastrophes

Scenario C: private actors in a good economic and technological environment with a stable political situation and few threats

Participants (in alphabetical order): Dr. J. Burbiel (Fraunhofer INT), Dr. S. Chmel (Fraunhofer INT), Dr. W. Fischer (Research Center Jülich), Prof. Dr. G. Geiger (Technische Universität München), Pro. Dr. G.H. Geschka (Geschka & Partner), H. Hahnewald (Geschka & Partner), Dr. S. Heinrich (Prognos AG), G. Huppertz (Fraunhofer INT), C. Klein (Rheinmetall AG), Dr. D. Kock (Fraunhofer INT), Dr. H.-J. Kruse (Rheinmetall AG), M. Levin (European Defense Agency), C. Melcher (Federation of German Industries), Dr. S. Müller (Fraunhofer INT), C. Raab (Copura GmbH), Dr. N. Schmitt (EADS Innovation Works), Dr. J. Schulze (Fraunhofer INT), M. Schwarz-Geschka (Geschka & Partner), Prof. Dr. H. Spitzer (Universität Hamburg), Dr. O Teichert (VDI Technologiezentrum GmbH), P. Thesing (Fraunhofer INT), D. Thorleuchter (Fraunhofer INT), A. Vergin (Zentrum für Transformation der Bundeswehr), Dr. P. Zoche (Fraunhofer ISI).

At first glance, the comparison between scenario A and scenario B and their impacts on security research showed surprising matches:

- Traditional defense technology gains importance,
- Military and civil security research remain – at least in part – separate areas of competence,
- Security research alignment is essentially influenced by governmental decision-making.

In both cases, security research – with different research focuses – becomes increasingly more complex and interdisciplinary.
In contrast to scenario B, scenario A is based on the assumption that asymmetric threats also strongly increase. Above all, this would necessitate an increase in police work, global networking of police institutions and corresponding research focuses.

In scenario B, an increasing danger originates from a growing number of natural catastrophes, necessitating investments in emergency management and prevention research.
Scenario B assumes other economic framework conditions for security and defense-relevant research than scenario A.
As Germany loses its economic and technological position, investments in research decline e. g. due to withdrawal of investors or reduced government funding.
Thus, it would not be possible to conduct high-tech research at the same top level as in scenario A.

When comparing scenarios A and B to scenario C, several distinct differences regarding future security research became evident:

- Traditional defense loses importance due to decreasing symmetric threats;
- The line between military and civil research becomes blurred;
- Due to the withdrawal of the government, security research is largely ruled by the demand and marketing opportunities of security technology producers or service providers.

Discussing all scenarios it became apparent that security and defense-related research is not only strongly influenced by form and intensity of existing threats, but it also depends on the respective main actors (private vs. public clients, research bodies, end users etc.).
Within the study these factors turned out to be the essential driving forces for the development of the scientific landscape in the area of security and defense.

Lectures

Chmel, S.: **Seminar über Kernmodelle und ihre experimentelle Überprüfung**, Sommersemester 2008, Universität Bonn

Chmel, S.: **Advanced Physics I (Atomphysik)**, Masterstudiengang, Wintersemester 2008/2009, Fachhochschule Koblenz, Rhein-Ahr-Campus

Chmel, S.: **Advanced Physics II (Kernphysik)**, Masterstudiengang, Sommersemester 2008, Fachhochschule Koblenz, Rhein-Ahr-Campus

Chmel, S: **Advanced Physics II (Festkörperphysik)**, Masterstudiengang, Sommersemster 2008, Fachhochschule Koblenz, Rhein-Ahr-Campus

Jovanovic, M.: **Bibliometrische Analysen**, Lehrauftrag an der Heinrich-Heine-Universität (Seminar), Düsseldorf, Sommersemester 2008

Jovanovic, M.: **Projektmanagement**, Lehrauftrag an der Heinrich-Heine-Universität (Seminar), Düsseldorf, Wintersemester 2008/2009

Wiemken, U.: **Einführung in die Technik**, Fachhochschule Köln, Fakultät für Informations- und Kommunikationswissenschaft, Köln

Wiemken, U. in Zusammenarbeit mit Burbiel, J.; Grüne, M.; John, M.; Jovanovic, M.; Kohlhoff, J.; Neupert, U.; Pastuszka, H.-M.; Reschke, S.: **Aktuelle Entwicklungen in der Technik**, Fachhochschule Bonn-Rhein-Sieg, Fachbereich Elektrotechnik, Maschinenbau und Technikjournalismus, Sankt Augustin

Wirtz, H.: **Investition, Finanzierung, Steuern**, Wintersemester 2007/2008, Sommersemester 2008, Wintersemester 2008/2009, Hochschule Fresenius, Köln

Wirtz, H.: **Investition und Finanzierung**, Sommersemester 2008, FOM Fachhochschule für Oekonomie & Management, Essen

Wirtz, H.: **Accounting & Taxes**, Wintersemester 2008/2009, FOM Fachhochschule für Oekonomie & Management, Essen

Wirtz, H.: **Handelsbilanz**, Wintersemester 2007/ 2008, FOM Fachhochschule für Oekonomie & Management, Essen

International Cooperation

Jovanovic, M.:
- Internship am Parlament der EU im Büro des Abgeordneten MEP Dr. Jan-Christian Ehler, November 2008 bis März 2009

Köble, T.; Rosenstock, W.:
- Mit Prof. Vadim L. Romodanov, Experimental Reactor Physics Institute, MEPhI, 115409, Moscow, Kashirskoe Shosse 31, Russian Federation, und seiner Arbeitsgruppe wurde im Rahmen des kanadisch-europäischen Projekts ISTC 2978 "Digital technology for the control of fissile materials in devices with pulsed sources" Detektionsverfahren für Spalt- und Explosivstoffe in Koffern an Fughäfen diskutiert. Weitere Kooperationspartner sind Universita Degli Studi di Bari/Dipartimento Interateneo di Fisica (Italien) und Bubble Technology Industries Inc. (Canada).

Missoweit, M.:
- Unterstützung des BMVg Rü IV 2 bei den R&T PoC Sitzungen der EDA
- Unterstützung des BMVg Rü IV 2 bei der Erstellung der "European Research & Technology Strategy" der EDA
- In Zusammenarbeit mit Frankreich und unter Leitung von BMVg Rü IV 1: Unterstützung bei der Entwicklung einer "European Defence Research Centers (EDRC)" – Initiative bei der EDA
- AP-Seminar "Internationale F&T Brüssel": Gespräche mit EDA (Capability und R&T Directorate); FhG Büro Brüssel; Michael Langer (Vice President Externals Affairs EU/NATO Head of the Diehl); Dr. Wenzel (Leiter des Rüstungsreferats NATO); Dr. Ehler (MdEP); Dr. Buck (Ständige Vertretung der BRD bei der EU)

Pastuszka, H.-M.:
- Unterstützung Präsident BBK bei der Leitung der ESRIF (European Security Research and Innovation Forum) AG4 "Krisenmanagement", sowie Mitarbeit im Rahmen dieser AG

Rosenstock, W.:
- European Security Research and Innovation Forum (ESRIF), WG 6 CBRN, speziell: Key technological developments enabling R&N-development & deployment
- Teilnahme an den Sitzungen der Working Group on Verification Technologies and Methodologies (VTM), die von der Non Proliferation and Nuclear Safeguards Unit im Joint Research Centre in Ispra, Italien, organisiert wird. Das Gebiet Verifikation (allgemein, nicht nur nuklear) wird dort permanent für die ESARDA (European Safeguards Research and Development Association) bearbeitet.

Suhrke, M.:
- Mitarbeit in der NATO RTO SCI-198 Task Group Protection of Military Networks Against High Power Microwave Attacks
  Treffen: Brüssel, 30.01.-01.02.2008, Farnborough (UK), 06.-08.05.2008, Kjeller (Norwegen), 14.-16.10.2008
- Proposal HPM Threat Scenarios, US/GE Science and Technology Workshop, Reston, 04.-05.03.2008
- Mitglied der ESRIF Working Group 2 Security of Critical Infrastructures
  Panel Meeting: Brüssel, 23.10.2008

Wiemken, U.:
- Mitglied der Subgroup für "Disruptive Technologies" im Rahmen der Kooperation der LoI6-Länder
- Member at large im IMC (Information Management Committee) der NATO RTO
- Mitglied der ESRIF Working Group 5 Foresight and Scenarios

Wiemken, U.; Römer, S.; Neupert, U.:
- Deutsche Vertreter in der NATO Task Group SAS 062 "Assessment of Possible Disruptive Technologies for Defence and Security"

Wiemken, U.; Römer, S.; Neupert, U.:
- Trilaterale Kooperation mit Schweden und den Niederlanden zu langfristigen Technologieentwicklungen

International Review Activities

Burbiel, J.: **Journal of Heterocyclic Chemistry**

Burbiel, J.: **Beilstein Journal of Organic Chemistry**

Kuhnhenn, J.; Metzger, S.: **IEEE Transactions on Nuclear Science**

Höffgen, S.; Kuhnhenn, J.; Metzger, S.: **RADECS Conference**

Schmidt, H.-U.; Suhrke, M.: **IEEE Transactions on Electromagnetic Compatibility**

Schulze, J.: **Pure and Applied Geophysics**

Suhrke, M.: **Mitglied des Programmkomitees des Symposiums EME 2009 "Elektromagnetische Effekte"**, BAkWVT Bundesakademie für Wehrverwaltung und Wehrtechnik, Mannheim

Collaboration in Committees

Schulze, J.: **Diskussionsrunde "40 Jahre NVV – Bilanz, Herausforderungen, Perspektiven" zur Vorbereitung der NVV-Überprüfungskonferenz 2010**, Berlin, 01.07.2008

Schulze, J.: **Schutzkommission beim Bundesminister des Innern**

Schulze, J.: **EuroTech Security Research Group**

Schulze, J.: **Stiftung Wissenschaft und Politik, Arbeitskreis Proliferation**

Schulze, J.: **DGAP** Task Force "Nichtverbreitung von Massenvernichtungswaffen und sensitiven Technologien"

Participation in Standardization Work

Participation in Standardization Work

Standardization work (VDE/DIN) by experts of the NE department:

IEC	IEC/TR 62283 (J. Kuhnhenn)
IEEE	Development IEEE P1682 (J. Kuhnhenn)

DIN/Electrontechnical standards:

NEA 760	Development of VG standards VG96900-96907, "NEMP- und Blitzschutz", Development of VG standards, part "Grenzwerte für Geräte" (H.-U. Schmidt)
NEA 763.2	Development of VG standards VG95370 ff., "Elektromagnetische Verträglichkeit" (H.-U. Schmidt)

VDE/DIN (German Electrotechnical Commission):

DKE 767.4.4	"TEM-Wellenleiter und Moden-verwirbelungskammern" (VDE/DIN-EMV standards) (H.-U. Schmidt, M. Suhrke)

Presentations 2008

Kohlhoff, J.: **Roboter – Vom Handhabungsautomaten zum Personal Robot**, Vorlesung "Technik und gesellschaftlicher Wandel – Rückblick und Ausblick", U. Wiemken et al., FH Bonn-Rhein-Sieg, Sankt Augustin, 11.01.2008

Burbiel, J.: **Psychopharmaka – Chemie für die Seele**, FH Bonn-Rhein-Sieg, Sankt Augustin, Vortrag im Rahmen des Seminars "Technik und gesellschaftlicher Wandel" im Studiengang Technikjournalismus, Wintersemester 2007/2008, 18.01.2008

Pastuszka, H.-M.: **Sicherheitsforschung – ein Überblick: Programme und Strukturen**, FH Bonn-Rhein-Sieg, Sankt Augustin, Vortrag im Rahmen des Seminars "Technik und gesellschaftlicher Wandel" im Studiengang Technikjournalismus, Wintersemester 2007/2008, 25.01.2008

Rosenstock, W.: **Struktur und Zusammenfassung Sachstand Bedrohungsanalyse**, 6. Sitzung der AG 1 Bedrohungsanalyse der NAG RB, ABC-Selbstschutzschule in Sonthofen, Jägerkaserne, 29.-30.01.2008

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Technology Analyses
Materials; nanotechnology; information and communications technology; space technology; biological technologies; robotics/unmanned systems

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Meta Analyses and Planning Support (AP)

National and International Research and Technology
Analyses and expert advice on national, European and transatlantic defense-related research and technology, on European security research, on defense industries and the European Security and Defense Policy (ESDP)

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Security and Aspects of Nuclear / Chemical / Biological Threats
Technological aspects of asymmetric threats; threat potential assessment of nuclear weapons, chemical warfare agents, and toxic industrial chemicals

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New Technologies
Feasibility estimates of novel system concepts in defense technology; consequences for research and technology planning

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Information Acquisition and Management
IT strategies; information systems on research and technology; methods of information structuring and visualization; XML applications

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Nuclear and Electromagnetic Effects (NE)

Electromagnetic Effects
Coupling of electromagnetic fields; electromagnetic compatibility (EMV, EMC); microwave measurement technique; High Power Microwave (HPM), electromagnetic threats

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Nuclear Detection Methods and Security Politics
Nuclear threats and risks, including terrorism; scientific aspects of security politics; state of development/potential misuse of nuclear weapons; assessment of the threat potential of nuclear weapons; disarmament and proliferation; nuclear verification with non-destructive measurement procedures; mobile nuclear measurement systems; neutron spectroscopy; active neutron interrogation; environmental radioactivity; radiation protection

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Effects of Nuclear Radiation in Electronics and Optoelectronics
Optical fibers; dosimetry with optical fibers; fiber-optic components; integrated optics; fiber-optic sensor systems; semi-conductor components; neutron irradiation; X-ray and gamma ray irradiation; proton irradiation; dosimetry; radiation detection

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Fields of Work and Contact Persons

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or
A61: Exit 26 "Swisttal-Heimerzheim"

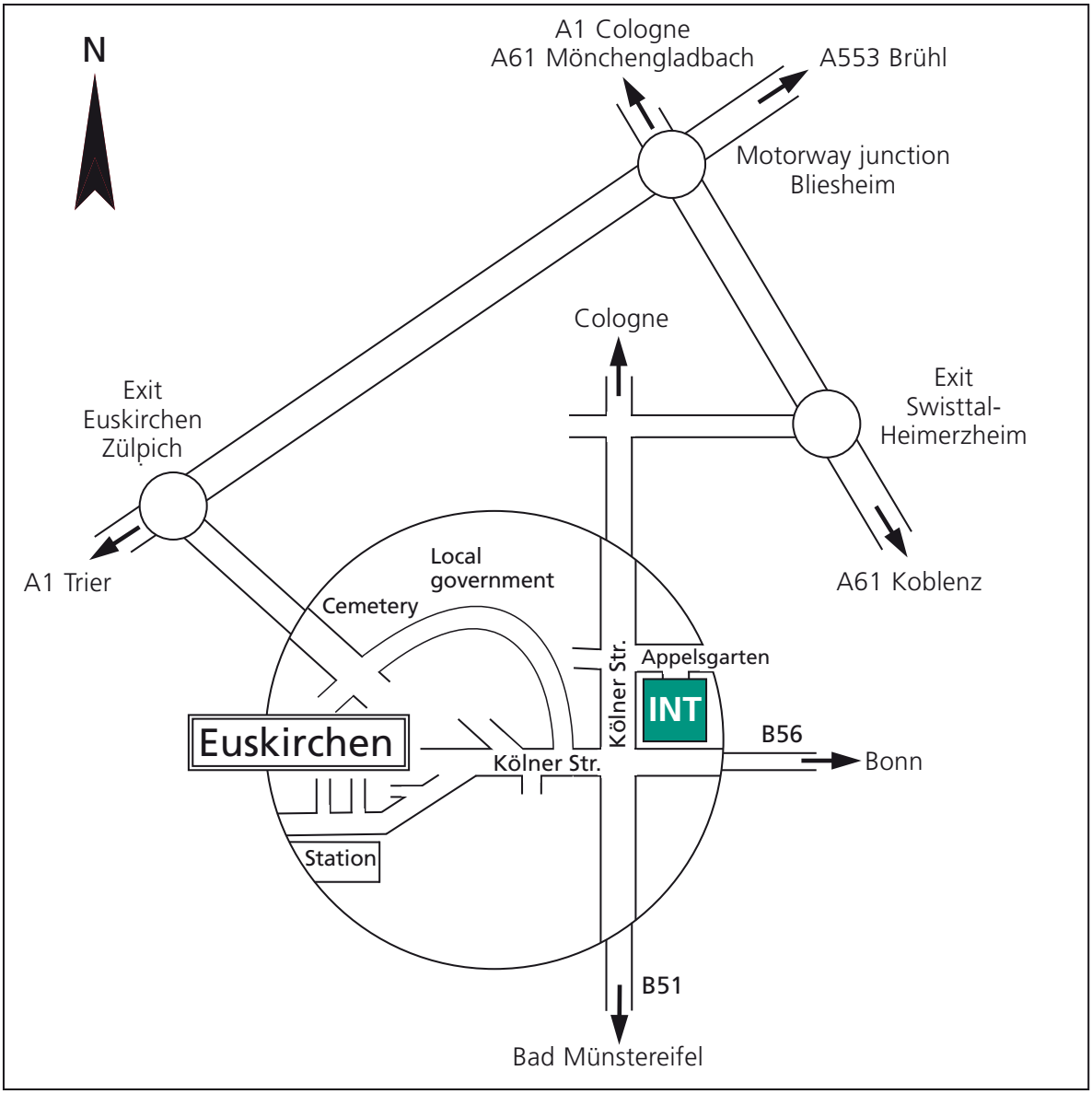
From Koblenz:
A61: Exit 26 "Swisttal-Heimerzheim"

By rail

Nearest IC stations:
Bonn central station/Cologne central station with regular connections to Euskirchen.

By plane

Nearest airports:
Cologne/Bonn (60 km) and Düsseldorf (100 km)



Editorial Notes

Impressum

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Linguistic support and translation
Thorben Jungbluth and Matthias Schulte

Photo aknowledgements
Ralf Hürten, Bad Münstereifel
Gina Hillmann, Fraunhofer INT (cover)
MEV Verlag (cover)
Udo Weber, Fraunhofer INT (page 47)

Layout & artwork
Konzeptbüro Horst Schneider, Erftstadt

Printed by
Warlich Druck, Meckenheim