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INT

FRAUNHOFER INSTITUTE FOR TECHNOLOGICAL TREND ANALYSIS INT

ANNUAL REPORT 2015

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Dear Reader,

"Sapere aude – Dare to be wise!" (or: "Make up your mind to understand!") – This could well serve as a rallying cry for all the inquisitive. And at least since the moment Immanuel Kant translated this quotation from Horace into "Use your own mind." – the credo of the Enlightenment – it has become a symbol for the endeavors of all who have dared to widen mankind's foundation of knowledge. Despite numerous set-backs because of false assumptions and wrong theories, we have to admit that this daring has been highly successful and has given us unprecedented progress in the last centuries.

Our knowledge has not only constantly increased, but its growth has also been exponential. Meanwhile, we can safely say that alone the databases listing scientific publications are doubling in volume every year - and this is just a small part of the annual increase in knowledge. Add to this the fact that our modern society's dependence on new knowledge is constantly increasing, it is more of a gamble not to want to know – or be able to know.

For an institution like INT, whose principle is to offer a comprehensive, complete overview of both the development of technology in general, and of radiation effects in particular, this represents a constant challenge that has accompanied our work for decades. Yet even with the large number of highly-qualified staff at INT, meeting this demand is becoming increasingly difficult; it requires sophisticated strategies.

And so we will probably have to soften Kant's imperative at least a little and explore how modern (information) technology – in the form of automated support systems – can assist our scientists' understanding and keep current developments in view. To this end, a major research project was initiated in 2015, which will occupy us intensively in the coming years. Substantial investments have already been made, and next year the Department TASP will be aligning its structures accordingly.

INT also looks back on other successful areas during a year which saw the foundations laid for future ventures. A cooperation agreement was signed with the University of Applied Sciences Ravensburg-Weingarten, giving us easier access to the high-tech region of Lake Constance. INT scientists are giving courses on future research as part of an innovative master's degree at the University of Weingarten, further broadening the academic support of the Institute. In this context, there is also good news from the Chair "Technology Analyses and Forecasts in Security Research" at RWTH Aachen University. With ever-increasing student numbers – currently about 130 in the winter semester 2015 / 16 – this course has also become well-established and will help us to generate master and doctoral theses for INT in the future.

The strategy developed in 2013 and launched in 2014 is beginning to bear fruit: in our Business Units, all indicators for 2015 show positive developments. A review of the strategy in autumn 2015 confirmed the chosen approach in principle. The need for improvement in a few areas was identified and directly reflected in individual business unit strategies.

The Institute was opened more widely to the outside world, as is necessary for successful business. Numerous industry contacts were established via our links to industry associations and there were corresponding activities at the Fraunhofer-Allianz Space office. An outstanding event was the evening jointly staged with the IHK Aachen, the Chamber of Commerce and Industry. Under the motto "Fraunhofer meets IHK", this event is held in one of the Fraunhofer Institutes in North Rhine-Westphalia every year, giving us an opportunity to present ourselves to a large audience of small and medium size industries.

So overall the course of 2015 leaves us looking optimistically at the coming year, during which we shall be accepting more exciting challenges with regard to increasing knowledge; many foundations have been laid and are waiting to be built on.

As always, our annual report will give you some insights here. So, don't hesitate, and dare to know! Enjoy reading it.

Best wishes,

Prof. Dr. Dr. Michael Lauster

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FRAUNHOFER INT IN PROFILE

The Fraunhofer Institute for Technological Trend Analysis INT provides scientifically sound assessments and counseling on the entire spectrum of technological developments. On this basis, the Institute conducts Technology Forecasting, making possible a long-term approach to strategic research planning. Fraunhofer INT constantly applies this competence in projects tailor-made for our clients.

Over and above these skills, we run our own experimental and theoretical research on the effects of ionizing and electromagnetic radiation on electronic components, as well as on radiation detection systems. To this end, INT is equipped with the latest measurement technology. Our main laboratory and large-scale appliances are radiation sources, electromagnetic simulation facilities and detector systems that cannot be found in this combination in any other civilian body in Germany.

For more than 40 years, INT has been a reliable partner for the Federal German Ministry of Defense, which it advises in close cooperation and for which it carries out research in technology analysis and strategic planning as well as radiation effects. INT also successfully advises and conducts research for domestic and international civilian clients: both public bodies and industry, from SMEs to DAX 30 companies.

THE BUSINESS UNITS IN THIS ANNUAL REPORT:

BUSINESS UNIT
DEFENSE TECHNOLOGY FORESIGHT

BUSINESS UNIT
INTERNATIONAL RESEARCH AND TECHNOLOGY MANAGEMENT

BUSINESS UNIT
PUBLIC RESEARCH AND TECHNOLOGY MANAGEMENT

BUSINESS UNIT
CORPORATE TECHNOLOGY FORESIGHT

BUSINESS UNIT
NUCLEAR SECURITY POLICY AND DETECTION TECHNIQUES

BUSINESS UNIT
ELEKTROMAGNETIC EFFECTS AND THREATS

BUSINESS UNIT
NUCLEAR EFFECTS IN ELECTRONICS AND OPTICS

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FRAUNHOFER INT FACTS AND FIGURES

Staff

INT personnel numbers remained constant with approx. 95 staff on permanent contract, plus about 20 assistants. With meanwhile 57 scientists, the Institute staff covers a wide range of natural and engineering sciences, as well as economics, social and human sciences. The researchers are supported by graduate engineers, technologists and administration specialists. INT also has a network of freelance scientists who are regularly involved in the Institute's work.

Budget

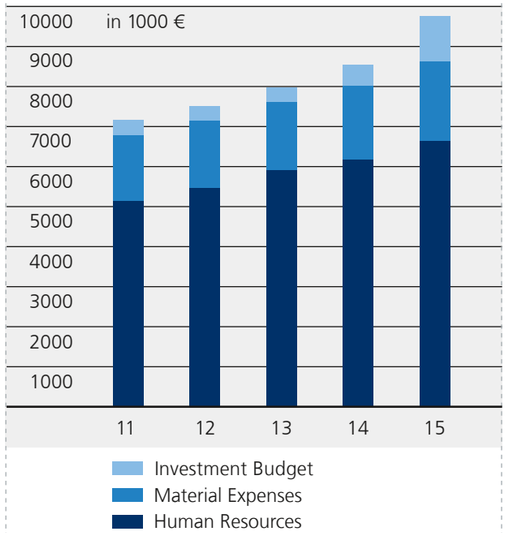
The Fraunhofer-Gesellschaft distinguishes between operating and investment budgets. The operating budget covers all staffing and administrative expenditure, the investment budget concerns the procurement of capital goods such as scientific apparatus and technical equipment. The operating budget in 2015 exceeded 8.6 million euros Together with the investment budget (excluding small construction work) of 1.1 million euros, the total budget amounted to more than 9.8 million euros.

As well as the amounts shown for investment in scientific infrastructure there is also the expenditure for extensions to the office building and for renovation and extension of laboratory capacity, which is billed on the central budget.

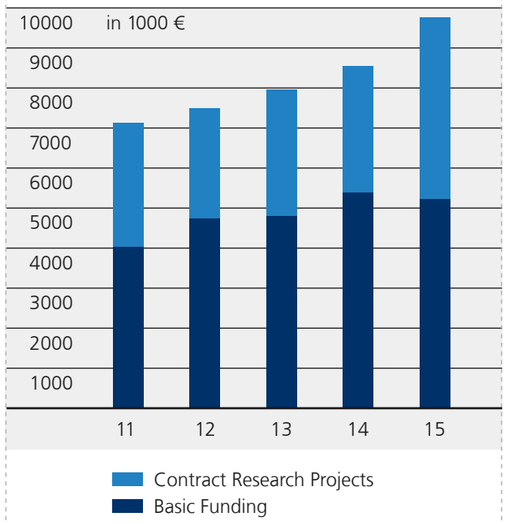
Along with basic funding from the German Federal Ministry of Defence (BMVg), which enables the implementation of a coordinated research program, INT also receives basic funding from Federal and Länder sources. Funding is applied within the Fraunhofer-Gesellschaft in accordance with performance criteria.

INT generates the remaining funds necessary for its budget through a large volume of contract research work. As well as the public sector, project clients in various industries range from small and medium-sized companies to DAX-30 groups, and also include associations and international organizations. There were again considerable increases in income, particularly from EU projects. In the public sector, our largest client is BMVg, for which we have been an in-depth consultant in research and technology planning for 40 years.

Budget from 2011 – 2015



Financial Development from 2011 – 2015



Human Resources

	2013		2014		2015	
	Manned positions	People	Manned positions	People	Manned positions	People
Scientists	51.9	55	53.4	56	53.9	57
Graduates	18.5	19	24.5	25	23	23
Technicians, Others	16.9	20	11.8	15	13.8	17
Assistants, Trainees	5.4	17	5.7	22	4.3	18
Gesamt	**92.7**	**111**	**95.4**	**118**	**95.0**	**115**

Budget

in 1000 €	2011	2012	2013	2014	2015
Expenses					
Operating Budget	6787.0	7146.0	7607.9	8027.6	8643.4
of which Human Resources	5150.0	5461.0	5915.7	6189.4	6660.5
of which Material Expenses	1637.0	1685.0	1692.2	1838.2	1982.9
Investment Budget	362.0	367.0	372.0	514.2	1116.2
Total	**7149.0**	**7513.0**	**7979.9**	**8541.8**	**9759.6**
Funding					
Basic Funding	4032.0	4772.0	4820.9	5405.8	5233.6
Contract Research Projects	3117.0	2741.0	3159.0	3136.0	4526.0

ADVISORY BOARD

1

The Institute is advised by an Advisory Board which is composed of people from industry, science, politics and administration.

Chairman:

Prof. Dr. Horst Geschka; Geschka & Partner

Members:

- Herr Udo Becker, Kreissparkasse Euskirchen
- Herr Dr. Walter Bernard; Diehl BGT Defence GmbH & Co. KG
- Herr Klaus Burmeister; Z_punkt GmbH
- Herr Dr.-Ing. Karsten Deiseroth; IABG GmbH
- Herr Prof. Dr. Horst Geschka; Geschka & Partner Unternehmensberatung Innovarium
- Herr Dr. Wolf Junker; Bundesministerium für Bildung und Forschung (BMBF)
- Herr DirWTD Rainer Krug; Wehrtechnische Dienststelle für Informationstechnologie und Elektronik (WTD 81)
- Herr Dir Prof. Dr. Winfried Schuhn; Wehrwissenschaftliches Institut für Schutztechnologien – ABC-Schutz (WIS)
- Herr MinR Norbert Michael Weber; Bundesministerium der Verteidigung (BMVg)
- Herr Dr. Hans-Ulrich Wiese
- Herr Dr. Thomas Weise; Rheinmetall Aktiengesellschaft
- Herr Prof. Dr. Dr. Axel Zweck; VDI Technologiezentrum GmbH

1 *Adivsory Board meeting on June 18, 2015*

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 67 institutes and research units. The majority of the nearly 24,000 staff are qualified scientists and engineers, who work with an annual research budget of more than 2.1 billion euros. Of this sum, more than 1.8 billion euros is generated through contract research. More than 70 percent of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and from publicly financed research projects. Almost 30 percent 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.

International collaborations with excellent research partners and innovative companies around the world ensure direct access to regions of the 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.

FRAUNHOFER VVS – GROUP FOR DEFENSE AND SECURITY

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The Fraunhofer Group for Defense and Security VVS was founded in 2002, chaired by Prof. Dr. Klaus Thoma.

The total budget of the Fraunhofer Group amounts to approximately 250 million euros per annum, and more than 2500 employees work for the ten VVS institutes.

The group considers its main objectives as follows:

1. Research and development of new technologies and solutions for the protection of people and the security of infrastructures
2. Research for national defense

Being committed to the German Federal Ministry of Education and Research (BMBF) and the German Federal Ministry of Defence (BMVg), the Fraunhofer VVS has come to assert itself as the driving force in the entire defense and security sector.

Even on a European level, the Fraunhofer VVS represents one of the key players and facilitates intensive networking with promising collaborative research activities.

Through excellent performance, the Fraunhofer-Gesellschaft significantly contributes to the future strategic orientation of the European security- and defense-research program.

Objectives

Security is an issue of growing social importance. Threats posed by terrorism operating internationally, organized economic crime, major accidents or extreme weather events represent a continuing challenge.

In the Fraunhofer Group for Defense and Security VVS, ten Fraunhofer Institutes have joined forces in order to face these challenges. As centers of excellence, they create intelligent and comprehensive solutions both for civil security as well as for defense in order to improve the protection of society against manmade and natural threats.

By pooling expertise and research activities, the Fraunhofer Group develops cutting edge technology and the accompanying concepts concerning methods, processes and tactics which are essential for facing the whole spectrum of potential and emerging security threats appropriately.

This implies the following tasks and functions:

- Providing advisory support for national and international R & D-policy
- Providing advisory support for the Fraunhofer management board
- Basic assessment and consulting capabilities for defense research
- Longtime oriented, collective platform of planning and action
- Coherent market communication
- Strategic orientation and further development of the Fraunhofer competences

Future Security Conference

Another important activity is the Future Security Conference, organized annually by the VVS since 2005. The conference was hosted in 2015 by Fraunhofer IAF. It took place in Berlin from September 15th to 17th under the slogan „Free but Secure“ at the permanent representation of the federal state North Rhine-Westphalia.

Member institutes are the Fraunhofer institutes for

- High-Speed Dynamics, Ernst-Mach-Institut, EMI
- Applied Solid State Physics IAF
- Chemical Technology ICT
- Technological Trend Analysis INT
- High Frequency Physics and Radar Techniques FHR
- Communication, Information Processing and Ergonomics FKIE
- Optronics, System Technologies and Image Exploitation IOSB
- Systems and Innovation Research ISI (guest institute)
- Integrated Circuits IIS (guest institute)
- Telecommunications, Heinrich-Hertz-Institut, HHI (guest institute)

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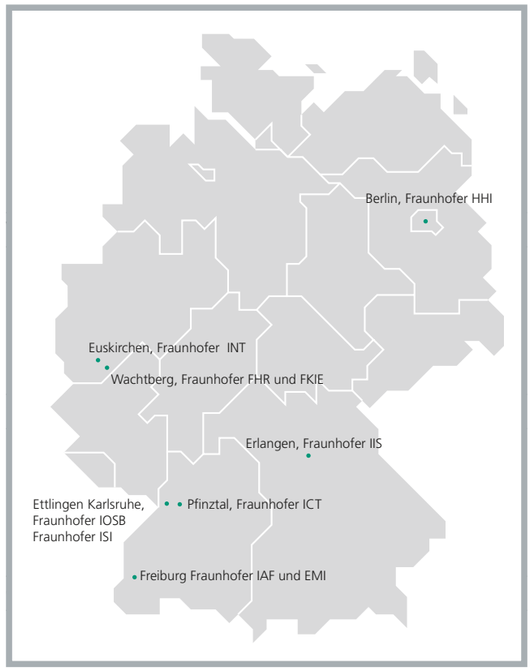
Fraunhofer VVS



1 *Chairman of the Group Prof. Dr.-Ing. Jürgen Beyerer, Fraunhofer IOSB*

TECHNOLOGICAL ANALYSES AND STRATEGIC PLANNING

Dr. René Bantes

Emerging from the 2013 Strategy Process, the Department "Technological Analyses and Strategic Planning – TASP" is staffed with 40 scientists, mainly from scientific-technical disciplines. TASP's task is to deliver the continual analysis, evaluation and forecasting of technological developments worldwide, and thus derive potential research and technology planning implications for our clients. This core competence is based on Fraunhofer INT's widespread, systematic and continuous technology foresight process, complemented by expertise in technology innovation management.

These skills have been expanded in recent years by extensive efforts and significant progress in the methodology of technology foresight. Using the procedures thus established, TASP gains the insights from which it derives its client-specific products. These range from assessments of the overall future potential of a technology to the relevance of national and international players and of plans and programs in research and technology.

In addition to this, specific studies tailored to an application domain or a given technology are conducted upon requirement, to identify decision support for the client. If desired we can extend this to derive specific recommendations to serve as input for the client's decision making in strategic research and technology management.

Although the methods are essentially generic, the formats, conclusions and recommendations derived vary, depending on client requirement. To best serve client needs, TASP is structured in four Business Units, each of which addresses different clients and their varying analysis requirements:

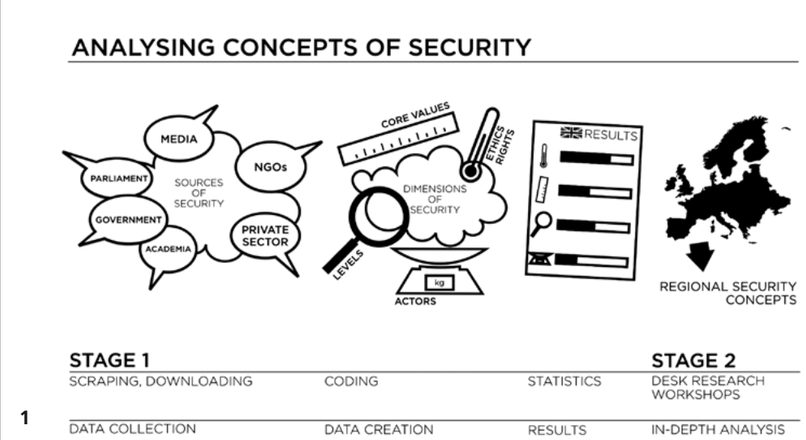
- Defense Technology Foresight
- Public Research and Technology Management
- International Research and Technology Management
- Corporate Technology Foresight

These Business Units and their activities in 2015 are described in detail on the following pages.

Besides processing client projects within the Business Units, TASP continued to develop in 2015, largely by focusing on the expansion of methodological basics for scientific work. To this end, specific work in internal projects created foundations for TASP's activities in 2016 and the following years.

REACHING INTO THE BRUSSELS "BUBBLE" – SUCCESSFUL COMPLETION OF THE EVOCS PROJECT

Dr. Miloš Jovanović, Dr. Joachim Burbiel, Dr. Gerald Walther



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At the final conference for EvoCS in November 2015, a question from the floor asked why EU officials no longer took account of the national aspects of the public security debate. One of the panelists said he had no answer to offer, since he had been working at EU level for years. This had kept him on a kind of "bubble", where national interests rarely played a role. This apt comment put one of the main objectives of the EvoCS Project ("The Evolving Concept of Security – a critical evaluation across four dimensions") in a nutshell: to make EU decision-makers aware of the content and tendencies of the public debate on security questions in selected European countries.

As the name of the project suggests, the EvoCS project (duration: from June 2014 to November 2015) dealt with the safety concepts of various European countries, as reflected in the public security debate and its development over the past decade to the present day. In order to obtain the broadest possible basis for analysis, a total of 12 countries in four EU model regions were selected according to different criteria (e. g. size and political development):

- Western Mediterranean EU (Italy, Malta, Spain)
- Eastern EU border (Poland, Hungary, Lithuania)
- Northwestern EU (United Kingdom, Netherlands, France)
- Southeast Europe (Serbia, Bulgaria, Turkey)

The Project also designed and continued to develop the framework for analyzing the security discourse in these 12 countries. It has a two-step approach, the first of which foresees highly standardized data collection and encoding. Information from various public sources was encoded in given dimensions (e. g. security strategies, parliamentary debates or articles in the press).

The scope included core values (such as physical integrity) or actors in the security sector (such as governments, media or parliaments). After encoding a source, statements were possible, for example on what the core values of the source were, or who was discussing them, or what the security issue was (e. g. terrorism or flooding). On the basis of codification, statistics were collected and interpreted, and in-depth studies were carried out (this being the content of step two). The national analyses for each sample state were then combined in analyses for the whole region (see Figure 1 for an illustration of the individual components of the analyses). These analyses finally led to the formulation of recommendations for policy-makers and security addressees at EU level, to support work on future security strategies for example. These recommendations and the reports on the national and regional analyses can be downloaded from the Project homepage at www.evocs-project.eu.

To acquire data from the security sector, several expert workshops were staged during the Project. The analytical framework and the latest results were presented and discussed in the workshops. The final conference in Brussels marked the conclusion of the substantive exchanges that had taken place between the scientific and political communities during the Project. Project consensus is that the methods and results of EvoCS can and should be used for other projects in the future.

An example is applying the EvoCS method to new areas, such as the refugee crisis debate in Europe. Here, too, the EvoCS project results could be used to build connections to the Brussels "bubble" referred to above. Even if not every EU policy-maker lives inside such a "bubble", projects such as EvoCS can help to ensure that safety strategy thinking takes greater account of citizens' needs, and is implemented more efficiently.

1 *Elements of the EvoCS Analysis (sources, dimensions, results)*

TECHNOLOGY WATCH PILOT STUDY – IT SUPPORT FOR EDA TECHNOLOGY FORESIGHT

Dr. Marcus John, Hans-Martin Pastuszka

For the European Defence Agency, one central objective is to identify, analyze and assess new technological developments for EDA's research and technology planning. Assessment takes particular account of the importance for European defense and the relevant development of military capabilities. In this context, EDA sees itself confronted with various challenges. First, it needs to organize processes within its own field of tasks and responsibilities, so as not to substitute or duplicate work being done by its member states. Second, it is also true that EDA has to give the most efficient and effective consideration to the rapidly growing amount of relevant information – and this in the face of limited personnel resources.

EDA has subdivided the whole of its planning strategy for research and technology into three consecutive steps: Technology Identification, Technology Assessment, and Technology Prioritization. The first step focuses on the earliest possible identification of technological developments already relevant – or which may soon be relevant – for defense. This step also includes the task of continued observation of already identified technologies, with the objective of recognizing technological breakthroughs early, to take account of any necessary re-evaluation of defense relevance. The second step assesses identified new technologies with regard to their concrete meaning for potential military use. From this, the necessary research requirement is derived. Finally, step three results in prioritization for EDA's concrete research planning.

In the first technology identification step, the focus is on recognizing and observing "emerging topics" among technologies. To this end, there has to be a study of the complete science and technology spectrum and it is necessary to keep an eye out for new topics. The EDA term for this is "horizon scanning". In addition, there is continuous observation of technological fields already known for their defense relevance, with the aim of tracking down new technological developments here as well. In this context, the term EDA has adopted is "technology watch". In both cases, the yearly growth of scientific publications poses an increasing challenge. Just for the field of nanotechnology as an example, the worldwide figure is one publication every six minutes. Technology foresight experts thus have to ask how papers of special interest for analyzing and evaluating defense-relevant technologies can be filtered out of the mass. As part of an EDA pilot study, WZA cooperated with the Spanish consultancy company Isdefe in a study of the extent to which a tailor-made IT tool can partially automate the task of filtering. The basic concept is to use computer-assisted processes to analyze and structure large, heterogeneous text volumes, thus considerably facilitating the work of the experts. Such approaches have been the subject of research for some time, both at INT and worldwide.

In the pilot study, the first task was to identify the key challenges of such a tool and to develop solution prototypes. This article deals with four selected problems that the pilot study considered closely.

In writing documents, the first problem is the question of choosing languages that the computer program should be able to process. Of course, the ideal vision for a tool that can be used internationally is the possibility of using all EDA member state languages. The platform should also be able to process documents written in other key languages, such as Russian, Chinese, Hindi or Japanese. The long term aim is automatic translation for these languages, but the necessary technology for this has not yet been perfected. With this in mind, and considering the pilot character of the project, it was agreed that for the moment English would suffice as lingua franca in science and technology. How other languages can be integrated into such a tool and what benefit this would bring to the user is to be investigated in possible follow-up projects.

The second question looks at what information sources the tool should be able to use and scan. This selection has a direct effect on how beneficial the technology foresight platform is from the user's point of view. A first limitation was that only freely accessible internet resources came into question. It was not possible to consider fee-based sources such as full texts from scientific journals. First, Isdefe and Fraunhofer INT drew up an overall list of more than 400 sources, largely based on the cooperating partners' own long years of experience in technology foresight. Subsequently selected from this list were those sources which the prototype tool retrieves and automatically evaluates. Selection first and foremost aimed at covering the specialist fields of all EDA CapTech working groups*. What posed challenges were the ability to automatically capture content using web crawlers, and the question of the legal rights of use. Several aspects came up regarding the Law. One question was whether and to what degree captured data may be processed or altered. Is automatic translation already an unlawful alteration of the data for example? Very important for the EDA project was also the question whether captured data may be stored and passed on to third parties – after all, access to the Technology Watch platform should not solely be for EDA staff, but also for experts from EDA's member states.

The third problem was the matter of how data can be suitably structured and saved. This question also has a bearing on which form should be used for presenting which research results to Technology Watch tool users. This is primarily about classifying the analyzed sources by means of a suitable taxonomy. Particularly in defense, there is a whole series of established taxonomies available for such a task; for EDA, the list is headed by the EDA Technology Taxonomy and the Capability Development Plan CDP. While the first allows classification from a technological perspective, CDP offers a capability-oriented view. However, to be able to carry out such classification automatically using a computer-based support system, it is necessary to develop a suitable vocabulary. In this case, this was done manually, and was one of Fraunhofer INT's major contributions to the Pilot Study.

Apart from all the algorithmic, legal and substantive questions that have to be addressed in such a project, at the end of the process there is still the EDA staff that use the tool in their everyday work. With this in view, the fourth complex considers the tool's user-friendliness. As well as the quality of the result, the influence of user-friendliness on whether an IT tool is actually accepted or not is something that cannot be underestimated. This applies to the user interface design, which has to be tailored to EDA specifications. It also means that the results need to be adequately visualized.

Outlook

The Pilot Study was successfully concluded at the end of 2015. Immediately after, EDA commissioned a follow-up study, to be jointly processed by Isdefe and Fraunhofer INT in the course of 2016. This project foresees extensive testing and further development for Technology Watch, as well as extending and tying in relevant aspects of the Technology Foresight.

BUSINESS UNIT “DEFENSE TECHNOLOGY FORESIGHT”

Hans-Martin Pastuszka

The Business Unit “Defense Technology Foresight (WZA)“ covers all services which Fraunhofer INT’s Technological Analysis and Strategic Planning Department (TASP) provides for the Federal Ministry of Defence (BMVg) and its downstream offices – in particular BAAINBw, the Federal Office for Bundeswehr Equipment, Information Technology and In-Service Support and its subordinates, as well as the Bundeswehr Office for Defence Planning (PlgABw).

The technology-oriented futures research Business Unit serves to provide its clients with reliable orientational knowledge and decision guidance on likely future developments in science and technology and their potential defense technological and military implications. In particular, this includes the early detection of emerging technologies and assessing client-specific technology, such as identifying the inherent opportunities and risks for defense. As well as focusing on technological issues, relevant international research planning processes and strategies are given crossover observation and analysis in the form of “country reports”, leading to recommendations for the client’s research and technology planning. WZA is thus making its contribution in gaining insights into future global technological developments, ensuring a broad analysis and assessment capability for clients in defense research and technology (R&T).

These services are provided by an interdisciplinary team of scientists and engineers within TASP. This guarantees all-enveloping competence in all relevant science and technology fields, complemented by comprehensive expertise in methodology and processes. The results are presented in the quarterly publication “Defense Technology Forecast (WTV, restricted)” – the Business Unit’s core product.

2015 was marked by three factors: the change in department leadership in March, by further consolidating the new department structure launched only the previous year, and by the continuation of a pleasingly high number of commissions for WZA from the German Federal Ministry of Defence (BMVg) and its downstream bodies. In consequence, the various offices were again provided with numerous decision-making inputs and science-based advice. This included, for example, several profiles of long-term technological trends as contributions to the Federal Government’s new White Paper 2016 (as already begun in the previous year), or statements on technological and planning issues that served to determine the national position on future research related to the EU’s “Preparatory Action on CSDP (EU Common Security and Defence Policy) research”.

Regarding contract research, WZA’s essential task lay in the continued provision of the Defense Technology Forecast (WTV) referred to above, which the client makes available to a broad readership in BMVg, its subordinates and the Bundeswehr. The WTV workshops launched in 2014 were continued with growing success, promoting information exchange and discussion between the Forecast’s authors and the many governmental defense sector users, and making it easier to seize on and implement specific recommendations. The three WTV workshops in 2015 attracted more than 50 participants from a wide variety of governmental defense organizations.

Over and above this main WZA task, last year also saw in-depth technology analyses on selected individual issues. A series of brief technology analyses was elaborated in continuation of the assignment from the Swedish Defense Material Administration (FMV). It was also gratifying to see that the cooperation started several years ago with the Bundeswehr Research Institute for Materials and Supplies (WIWeB) in Erding was renewed and intensified. This produced the study “Metamaterials – Composites with an Intrinsic Structural Hierarchy”, which provided a comprehensive overview of metamaterials, focusing on mechanical metamaterials. Using a combination of desk research and bibliometric methods, it was possible to identify potential military applications for these materials, as well as highly-dynamic current research fields and the major players.

Primarily for WZA, but also involving other units in the department, work and further development in 2015 also considered the question how technology scanning and monitoring within

TASP can be suitably supported by IT-based assistance systems. To this end, a research project under WZA was started up in the year under review. First, a cross-department market study was conducted, to get an overview of available software that can analyze large unstructured datasets and assess their content. In parallel, a first concept for such a system was set up.

Thanks to appropriate funding by the bodies concerned, high-performance content analysis software was then acquired and integrated into the Institute's IT environment. This was already followed up by the first prototype applications to facilitate integration of the software in INT's technology foresight process. An important focus for 2016 will be to continue this development and adapt the software to INT's specific requirements.

Thematically linked to this internal task was a commission from the European Defence Agency, under its "Technology Watch Pilot Study". In the course of 2015, WZA and the Spanish Government's consultancy and engineering office "Isdefe (Ingeniería de Sistemas para la Defensa de España)" collaborated in looking at how the continued analysis and assessment of technological developments can be assured for EDA. These studies, regarding general technological developments as well as relevant developments in the defense sector in particular – for example in military capability development – should be undertaken without substituting or duplicating similar activities in the Member States participating to EDA. A separate article on this project can be found in this Annual Report (see page 18).

Finally, Business Unit WZA was last year again involved in a series of educational and panel activities. A highlight was the jointly-conceived course module "Methods of Futures Analysis" at the Bundeswehr Staff College in Hamburg, organized and conducted in November by the Future Analysis section of PlgABw. As it did for the first course module in 2014, WZA again contributed with four lectures.

Also worthy of note was the appointment of WZA's Deputy Head, together with a colleague from the Business Unit IFT, to NATO's "Independent Scientific Evaluation Group (ISEG)". They will be active in the program "Science for Peace and Security (SPS)".

WZA's prospects for 2016 remain positive, despite the client's tight budget for R&T. Not least due to increasing assignments from EDA, above all through a follow-up study on the "Technology Watch Pilot Study" and a preparatory task for EDA's internal strategy development, there are justifiable hopes for the continued success of WZA.

BUSINESS UNIT “INTERNATIONAL RESEARCH AND TECHNOLOGY MANAGEMENT“

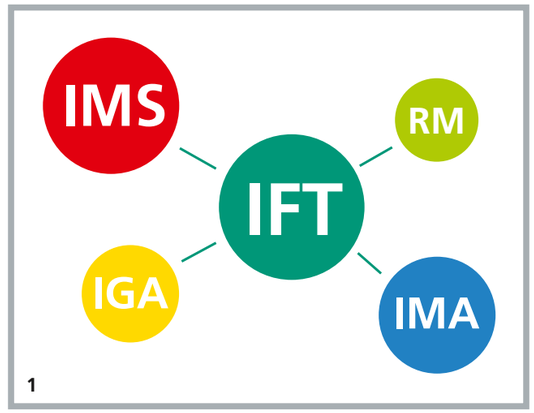
Dr. Merle Missoweit

The Business Unit IFT covers the international activities of Department TASP. Its clients are the European Commission, the European Defence Agency EDA, the European Parliament and international organizations and stakeholders in the areas of security and defense.

IFT focuses its research on evidence-based support for decisions in research and innovation management in security and defense. This mainly means foresight and scenario activity, technology assessment, roadmapping and contributions to capacity development, bibliometric and statistical analyses, and developing concepts for innovation management. In this context, the sector **Innovation Management for Public Security** develops and tests innovation management concepts to support policy and research decision makers. In 2014, a key activity in the area was the second phase of the FP7 demonstration project DRIVER (Driving Innovation in Crisis Management for European Resilience, 2014–2018). An important highlight here was the second event of the DRIVER conference series I4CM (“Innovation for Crisis Management”), jointly staged with “Technisches Hilfswerk” (THW), the German Federal Agency for Technical Relief, details on page 73.

In contrast, the area **Innovation Management for Security Actors** addresses individual authorities and organizations in security and defense, and supports them in the implementation of research findings.

Currently being set up is the **Resilience Management** area, thus extending the Business Unit’s portfolio. This activity concentrates on using innovation management methods to increase resilience – of critical infrastructures, for example – in cases of crisis and catastrophe. Here, in the second application round of the EU Horizon 2020’s “Secure Societies” program, INT was awarded funding for two research projects, one on resilience and critical infrastructure in smart cities, and the other on standardizing technologies and processes to increase resilience.



1

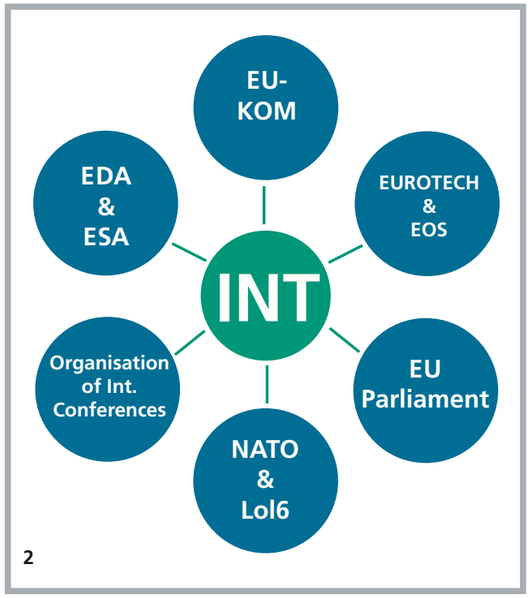
1 *IFT Sectors:*
IMS: Innovation Management for Public Security Provisions
IMA: Innovation Management for Security Players
IGA: Innovation and Social Acceptance
RM: Resilience Management

For some time, a task cross-linked to these three main activities has been broadening the connection with social issues on the acceptance of security technologies and concepts. Under the coordination of IFT, the FP7 Project EvoCS (“The Evolving Concept of Security”) was successfully completed last year (more details on page 16). Also continuing are the European Network of Excellence SOURCE – Virtual Centre of Excellence for Research Support and Coordination on Societal Security, and corresponding work in the DRIVER project. A further Horizon 2020 research application was also successfully submitted.

Other highlights of 2015 were the conclusion of a framework agreement for the evaluation of research activity at the Direc-

torate-General HOME (“Migration and Home Affairs”) of the European Commission, and a number of defense projects that were undertaken for the European Defence Agency.

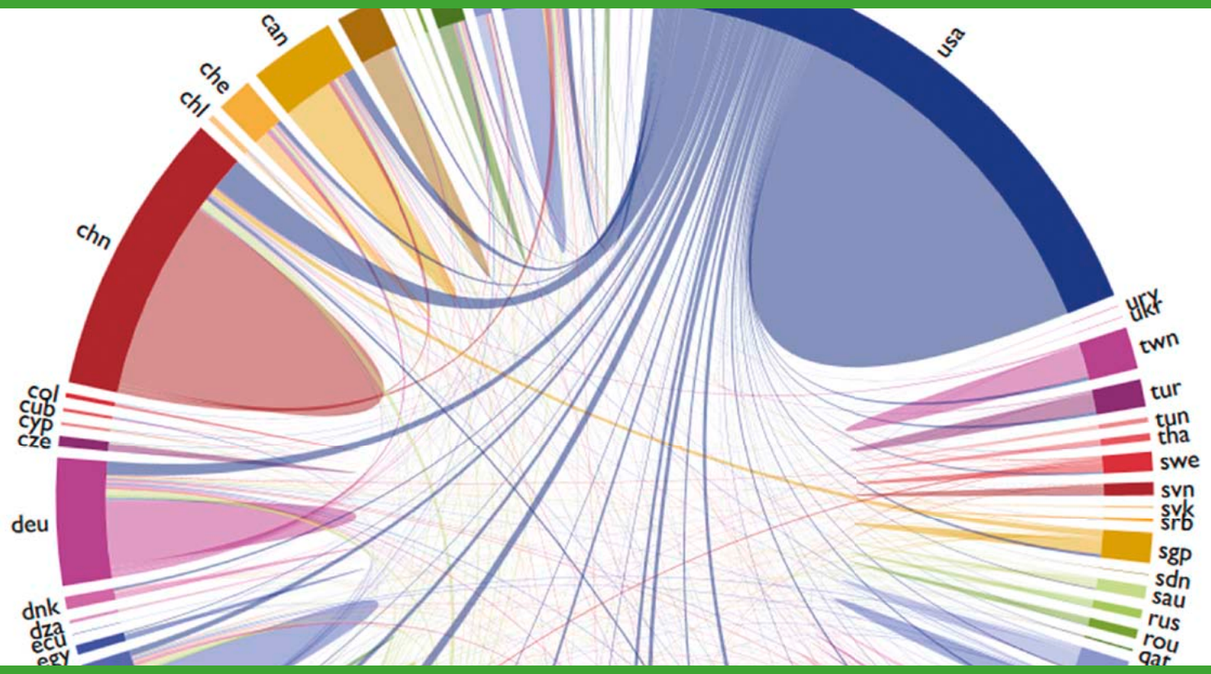
IFT’s wide expertise not only becomes evident through its renewed appointment to the H2020 “Protection and Security Advisory Group”, but also through its appointment to the cross-discipline H2020 Advisory Group for “International Cooperation”. IFT provides an expert for NATO’s “Partnership for Peace” program, and represents the Fraunhofer Group for Defense and Security Research (Fraunhofer-Verbund für Verteidigungs- und Sicherheitsforschung – VVS) in the “Security Working Group” of the European Association of RTOs (EARTO).



2 *International Network and Bodies*

BUSINESS UNIT “PUBLIC RESEARCH AND TECHNOLOGY MANAGEMENT“

Dr. Joachim Burbiel, Dr. Silke Römer



The Business Unit “Public Research and Technology Management” (ÖFT) is specifically aligned to public, non-military clients in Germany. It deals with research management questions (e. g. “How can research funds be spent wisely?”), and technology management (e. g. “What technologies will need more attention in the future?”). It applies traditional planning support instruments such as roadmapping, and participatory methods such as scenario workshops or the World Café.

In addition, the division has specialists who address questions about how knowledge can be organized and presented, or who deal with the technical analysis of large amounts of information, e. g. in scientometrics. These in-house skills take the service portfolio beyond purely scientific dimensions.

The year 2015 was marked by continued growth for the Business Unit. Accordingly, a meeting in March with representatives of “Technisches Hilfswerk” (THW), the German Federal Agency for Technical Relief, prepared the way for a cooperation agreement. In July, coordination talks were held with members of the Bavarian State Criminal Investigation Office.

ÖFT also processed two further projects in 2015: since mid-year ÖFT has been collaborating with Fraunhofer MOEZ (The Fraunhofer Center for International Management and Knowledge Economy) and the Technopolis Group, on a comprehensive evaluation of joint research under BMBF (Federal Ministry of Education and Research) in the field of basic scientific research in large-scale facilities. Examined are the program’s objectives themselves, the funding achievement level, and the effect of each program’s objectives. Finally, evaluation results from a strategic audit form the basis for future recommendations for BMBF collaborative research funding.

The Business Unit made an important contribution to the study carried out by the VDI Technology Center (VDI TZ) on behalf of the Federal Ministry for Economic Affairs and Energy on the “Analysis of the structural situation of the defense industry in Germany”. This laid down the analysis framework for the project’s further progress.

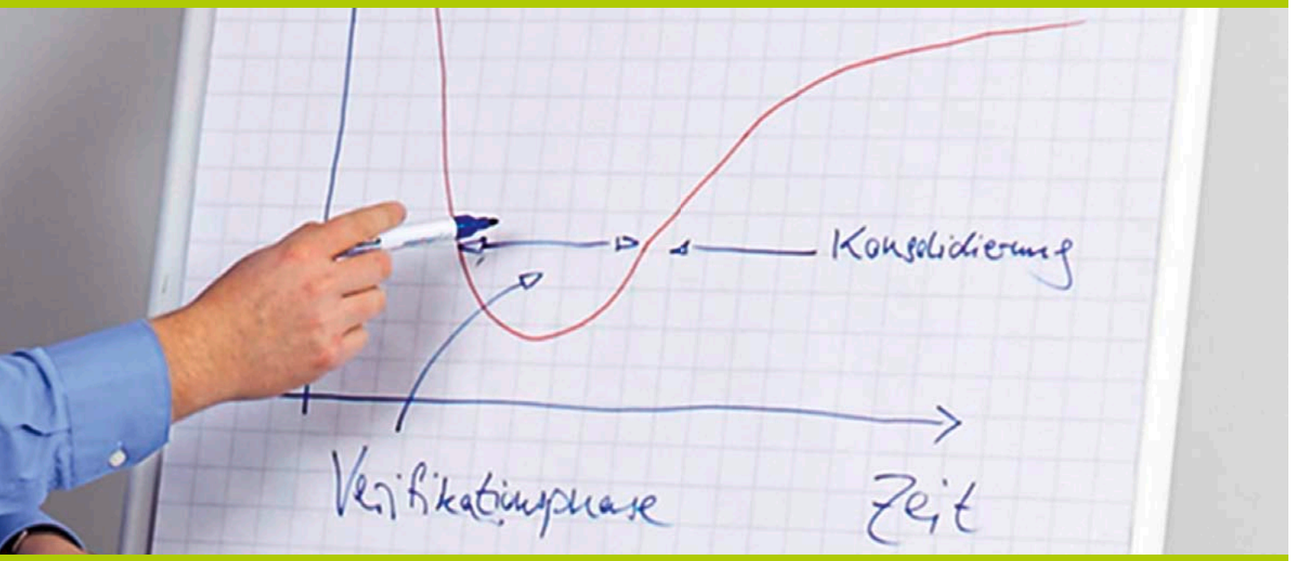
In addition to the definition and delimitation of the analysis subject – the “defense industry in Germany” within the meaning of the task as well as a critical analysis of potential demarcation approaches (geographic, integration into value chain, type of products and services within existing grades) – ÖFT collaborated with VDI TZ and the Brandenburg Institute for Society and Security GmbH (BIGS) to identify and analyze economic characteristics of the defense industry in Germany.

The Internet portal “European Security Research” (esfo, www.sicherheitsforschung-europa.de) was twice updated in 2015 to give the general public access to reliable information on key programs, players and backgrounds in this research field.

Since the years 2014 and 2015 showed a large overlap of services offered by ÖFT and IFT, a merger of the two Business Units is planned for 2016.

BUSINESS UNIT “CORPORATE TECHNOLOGY FORESIGHT”

Dr. Martin Brüchert



The Business Unit Corporate Technology Foresight (CTF) focuses on technology, innovation and the future for the business world. With in-depth scientific methods applied research by the unit supports a wide range of companies in questions of long term successful strategies and innovation management. CTF shows up future technological changes, analyzes and assesses them and, together with the client, develops solutions and plans. Broad technology screening reveals trends, risks and the potential of new technologies for the business community.

In general, the starting point is the comprehensive overview that the whole Technology Analysis and Strategic Planning Department has of almost the entire future technology landscape, with a time horizon stretching from current changes to the long-term. In an age where innovations change whole business sectors, this supports companies in the timely recognition of cross-industry innovations and in taking a look beyond the company horizon. This can also benefit specific company strategy by pointing up and breaking down complex technological changes, such as foreseen in the German Government’s high-tech strategy “Industry 4.0”.

As well as the overall perspective (360°), the entire planning horizon is covered, from short to long-term forecast. Developing such competence internally is usually too costly, especially for small and medium sized enterprises. This keeps long-term complex technological developments out of reach for many, although they are of great importance for a company’s long-term success.

CTF closes this gap for companies or supplements a company’s own vantage point with a neutral perspective, thus helping to develop a sustainable, long-term technology strategy for each client. The basic questions are: What technological developments can we expect? What technology is sustainable and can be used as long as possible until the next change? What new technologies will change my business operations or even make them obsolete? What new products or services can be realized with future technologies?

With CTF answering these questions, trends and technological developments are moved into a company-relevant context, possible development paths are identified, their meanings are analyzed and recommendations for action are developed. At the same time a strategy can be applied to match expected long-term developments. Especially the latter cannot succeed without expertise on participatory methods and a close, trusting relationship – as is customary with Fraunhofer INT.

These services are based on the central skills of technology analysis and strategic planning and the systematic technology and planning monitoring of the department TASP. This generates fundamental knowledge on trends across virtually the entire technological spectrum; knowledge that can be quickly absorbed into projects and customized to client requirement. A business-oriented view of technology trends is a CTF characteristic. Examples of typical CTF activities are the projects “Bezahlen 2025” (Payment 2025) and “Technologie-Scanning-Analyse” (Technology Scanning Analysis).

Payment 2025

In 2015, CTF and Z_punkt collaborated to create a study under the title “Bezahlen 2025” for SRC Security Research & Consulting GmbH, to look at how we will be paying in Germany in the year 2025. In ever shorter intervals, new methods of payment are currently being introduced, established and promoted by a great variety of providers and based on very different technologies. The payment sector’s future is currently undergoing a major transformation, and is therefore extremely uncertain. Established players are at risk of being ousted from the market and cut off from the payment interface that will be so important in the future.

Together with experts from the banking world, four possible future scenarios for 2025 were developed and coupled with

the technological developments possible. Questions raised in studying each scenario include: Who is the dominant player in the scenario? Which technologies (e. g. authorization technologies) will be employed and dominate? How will customer behavior develop? Which business models will be used? What does the scenario mean for the players here and now? The overall analysis of all scenarios pointed up which factors are certain and relevant for numerous scenarios, and which uncertain developments and factors can the players influence critically. The analysis also looked at which factors are absolute game changers and may cause major change. The technologies identified were also investigated with regard to their disruptive potential.

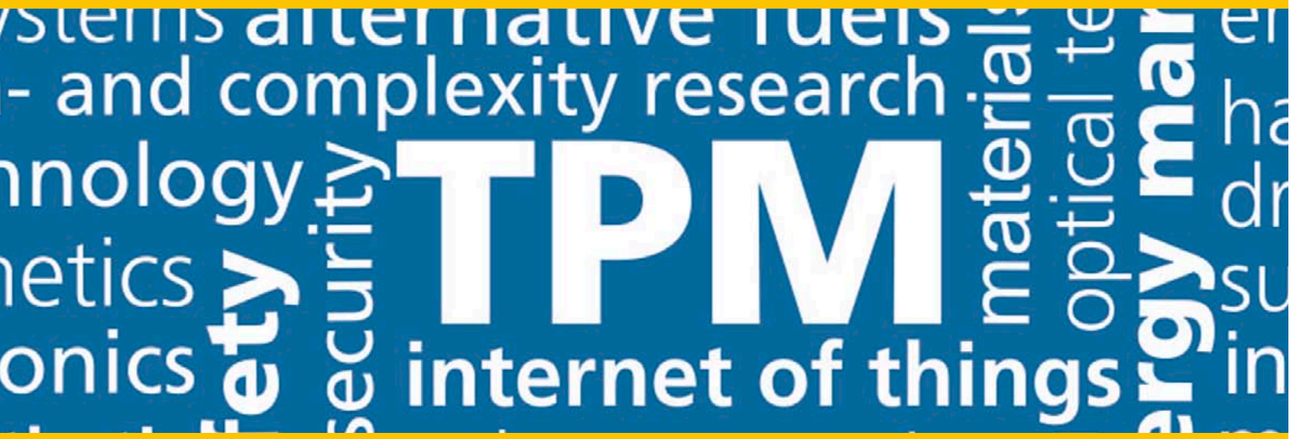
Thus, the study is intended to be a tool to show the players the risks and needs for action, to help derive new business models and, finally of course, to develop long term successful strategies and plans. With the help of this study, the players can assess which scenario is desirable for them, which direction current developments are moving in, and what action needs to be taken in consequence.

Technology Scanning Analysis

In 2015, CTF supported one of the world's leading automotive suppliers in launching and creating the settings for its own technology scanning system, with the aim of reaching a comprehensive, secure identification of new technology topics. Using a concrete technology area, a comparison was drawn up between the client's and INT's foresight processes. This reviewed different approaches and the associated results, and enabled adjustments to technology scanning parameters. The method applied was the White and Blind Spot Analysis. The result produced recommendations for which parameters (sources, time horizons, technology networking, etc.) are to be used in the technology foresight in order to guarantee blanket technology disclosure. The project thus included not just the content side, but the technology foresight process factor as well.

STRATEGIC PROJECT: TECHNOLOGY TRENDS AND STRATEGIES

Dr. Claudia Notthoff



The main task of the strategic project Technology Trends and Strategies (Technologie- und Planungsmonitoring – TPM) is to continue developing the monitoring processes established at INT. By adapting these processes to new challenges associated with the concept Big Data, INT continues to secure comprehensive, systematic and ongoing **technology foresight**. This includes the development of "Neue Technologien (New Technologies)", an information platform which is geared to the needs of INT's business units.

To define the technology monitoring fields, it was decided to choose a perspective approach that demonstrated the complete coverage of the whole breadth of technology, by comparing with overarching taxonomies of purely technological nature. Using this approach, each monitoring field can be considered as a viewpoint from which developments in the technologies concerned can be observed. This way, very different observation levels are consciously taken in. Technological developments are monitored, taking account of both technical/specialist aspects (e. g. robotics) or of particularly innovative applications (e. g. vehicle technology), or of currently pressing social needs (e. g. service innovation). The fact that the same technology developments can occasionally be observed from different angles (e. g. service robots) – from both the "service innovation" and the "robotics" perspectives – serves to increase hit probability and safeguard monitoring results.

To support and document the monitoring process, the **information platform** "**Neue Technologien (New Technologies)**" has been developed. From 2016, this platform will allow INT staff to record new technological trends and developments, making it easier for staff to identify and access the material on file. Also built in is a system for extracting important data by using simple technology cards.

In line with successful and comprehensive technology monitoring, TPM works with the journal "Europäische Technik und Sicherheit (European Security and Technology). TPM organizes and edits the section "**Neue Technologien (New Technologies)**", where INT discusses current technological developments, especially highlighting applications and future potential.

Also closely linked to our main task are the **technology cards** that TPM developed as part of the EU project "SOURCE". Technology cards give a précis description of the technology, as well as an overview of the research and development level. They point up drivers and obstacles and list key players and potential users. Likewise, follow-up sources are cited. As well as internal tasks for INT, TPM also provides internal service for Fraunhofer. With TPM working in cooperation with Fraunhofer Institutes ISI, IAO and MOEZ in 2015, it was possible to develop standardized technology analyses, short technology research projects and blind spot analyses; these were applied in follow-on projects.

Technology analysis can help assess the attractiveness of a larger or higher-level technology field for the Fraunhofer-Gesellschaft, and demonstrate its competitor status in the field. The procedure is similar to classic technology portfolio assessment, as often carried out by companies. However, it was adjusted according to requirement, as Fraunhofer does not focus on marketing a product; instead, the goal for Fraunhofer is research activity itself.

A technology analysis begins with describing and structuring the technology. Subsequently, the technology field's general attractiveness for Fraunhofer is estimated with the help of patent and publication analyses and, where appropriate, supplemented by expert interviews. Finally, Fraunhofer's position in the field is determined on the basis of secondary analyses.

In principle, **short technology research** is structured along the same lines as technology analyses. Owing to shortened processing time and more narrowly-defined subject areas, the presentation of research and analysis results is more in the form of an overview. In summer 2015, for example, a short research program was carried out for Fraunhofer HQ, with the topic of rechargeable batteries. Special emphasis was set on studying

the main players' activities in Germany in comparison with what key players were doing globally. To this end, the technology field was outlined and defined, and current research trends were identified. Some exemplary findings are summarized below.

Short technology research also included the use of secondary analyses to determine the position of the competitors in the research field. Against the backdrop that the attractiveness of a research field is determined not only by dynamics, but also by the competitive situation of the stakeholders, the position of the research community was assessed on the basis of its patents, publications and public funding.

In addition to technology research, so-called "blind spot analyses" were developed. They are used to assess the attractiveness of potential business areas for the Fraunhofer Gesellschaft – areas which are treated much more intensively by comparable R & D institutions. These analyses include a short description of the parent technology field, a structuring of the relevant sub-theme, an assessment of the attractiveness of the field for Fraunhofer in general and the positioning of Fraunhofer with regard to the parent topic and the technology field chosen. To estimate future market potential, future studies and relevant publications are studied, and the dynamics of the research market are assessed with the use of patent and publication analyses.

High Temperature Batteries

High temperature batteries using sodium-nickel chloride (Na-Cl Ni) or sodium-sulfur (Na-S) are already well advanced technically, and are especially interesting for traction applications (e. g. buses). Furthermore redox flow batteries are a promising candidate for the future, especially for large stationary applications. Particular worth noting here is that the energy content is no longer limited by the size of the energy converter cell, but depends exclusively on the size of the installed tanks. In special cases, the charging process of redox batteries can be such that it in principle resembles the fueling of conventional automobiles. Because of present-day low energy density and the problematic environmental compatibility of currently usable electrolytes, redox flow batteries are initially mainly suitable for stationary applications.Still interesting is the lithium-ion battery in its different variants, for which further improvements can be expected in the future, also in terms of energy density. Alternatives to lithium-ion technology may be long-term sodium-ion batteries or doubly ionized magnesium-ion batteries. There is also great potential in metal-air batteries (esp. oxygen-lithium batteries), which could solve the range problems of battery-powered electric vehicles. The rapidly growing demand for portable energy sources also means that future battery systems will have to give much greater consideration to the existence and availability of materials used, as well as to energy efficiency and environmental compatibility in production and recycling. The mass production of relatively simple batteries seems to be rather unattractive for Germany; greater potential lies rather in more sophisticated products.

Blind-Spot-Analysis

An example of such a blind-spot analysis is **precision agriculture** or **precision farming**. In structuring this area, the online sensors sector was judged to be particularly relevant for Fraunhofer and therefore analyzed in depth. Precision Farming, or "präziser Ackerbau" in German, has been developed and used since the 1990s. It refers in general to the locally-differentiated and target-oriented cultivation of farmland. To optimize crop production, land management is supported by satellite-based positioning and geo-information systems, linked with modern sensor technology and machine control. This supports the full range of agriculture: crop planning and soil cultivation, sowing, fertilization, plant protection and harvesting. Important technologies are, for example, the Global Positioning System (GPS) and the geographic information system (GIS), as well as track guidance for tractors, specialized sensors and selectively controllable systems for sowing seed and spreading fertilizers and pesticides. First, application and research potential were presented to facilitate a statement on how attractive the research field was for the Fraunhofer Gesellschaft. Correspondingly, the current situation of public research funding in the entire field was also analyzed and an estimate of development in the coming years was carried out. Patent and publication activity in precision farming was observed, providing further criteria for assessing the pace of innovation. It was found that although Fraunhofer was already pursuing some individual research projects on this topic, it however does not count among the relevant actors. The analyses nonetheless showed that many of Fraunhofer's core research activities also play a role in developing technologies for precision farming.

NUCLEAR EFFECTS

Dr. Stefan Metzger

For the Department Nuclear Effects (NE), 2015 was in many respects a very positive year. Economically, it was the most successful year of NE's history stretching over more than 40 years. Revenues from contract research increased by more than 10 % to € 2.2 million, passing the 2 million mark for the first time. What especially stood out was the increase coming from projects for clients in industry. To handle the larger volume of work in addition to basically-funded activities, staff numbers were increased with four new appointments during the year. Fortunately, it was also possible to obtain substantial German Federal Ministry of Defence (BMVg) funds for strategic investments, securing, for example, the future viability of the Business Unit Electromagnetic Effects and Threats (EME). Strategically important was the first BMVg grant received by the Business Unit Nuclear Effects in Electronics and Optics (NEO) for feasibility work on the use of nanosatellites for military purposes. The aim of this project is the construction of an orbit-capable nanosat technology demonstrator, designed to carry payloads which detect missile launches and radiation events in orbit. INT's share of the task is modeling the radiation environment, forecasting the frequency of radiation-induced errors during operation, the radiation qualification of components and subsystems, and the on-board detection of radiation events with digital components.

A further strategic target for the Department is the expansion of expertise in Single Event Effects (SEE). Continuing and complementing earlier work in the energy dependence of SEE probability (Ref.: S. K. Höffgen et al., "Investigations of Single Event Effects with Heavy Ions of Energies up to 1.5 GeV/n", IEEE TNS 59 (4): 1161 – 1166, August 2012), new collaboration was launched with the Nuclear Physics Institute (IKP) Forschungszentrum Jülich (FZJ). Cooperation is working under the title "Investigating Proton-Induced Single-Event Effects in Modern Microelectronics up to 2.5 GeV". For the proposed work, an initial 10 days of beamtime using FZJ's COoler SYnchrotron (COSY) was approved up to mid-2016.

From 8 to 10 September, the Business Unit Nuclear Security Policy and Detection Techniques (NSD) staged the 7th symposium "Nuclear and Radiological Threats". The 14 presentations given in the two-day event covered topics such as the Iran Agreement, the verification of nuclear disarmament, terrorist threats and the Nuclear Test Ban Treaty. For many of the 43 participants, the meeting was more of a family gathering, since they had attended previous symposiums. NE's second major event was the 5th workshop titled "Herausforderung Weltraum" (The Space Challenge), from 11 to 12 November. For the first time, NEO was able to welcome 38 attendees from industry, research and the German Aerospace Center (DLR) in the new seminar building. As well as the eight talks, including two presentations from outside speakers, a highlight was the live demonstration of radiation experiments, as in previous workshops.

The Department's work was documented in 24 publications and 68 reports, as well as in other media. To keep up to date with research in the scientific community, NE also carries out important tasks such as consulting renowned professional journals, or taking part in and chairing international conferences. NE staff expertise also contributed to the work of various standardization bodies, such as DIN, IEC or NATO. On the whole, 2015 can be looked upon as a very successful year for NE's core work. Considering all the hindrances caused by ongoing construction work during normal operations, this is all the more remarkable.

With a view to 2016, we are very much looking forward to moving into the new office building, which will be providing new work space for (almost) all the staff. With all group members working closer to each other, internal communication will be more efficient and the "togetherness-feeling" will be enhanced. Beyond this, we expect improved working conditions in 2016 after laboratory refurbishment is finished.

Preliminary work for the certification of the Department's quality management system according to ISO 9001 is progressing steadily and will be culminating in an internal audit in the fall of 2016.

ANCHORS PROJECT – FINAL DEMONSTRATION

Wolfram Berky

After running for three and a half years, the Franco-German ANCHORS Project ended on October 31, 2015. It concerned the development and integration of a system of UAVs (Unmanned Aerial Vehicles) and UGVs (Unmanned Ground Vehicles) fitted with cameras, sometimes with sensors, for the purpose of detecting and identifying radioactive materials. By setting up a local network, the UAVs were able to communicate with each other and a mobile ground station, and so exchange flight and radioactivity measurement data. The system makes it possible for emergency services to conduct aerial surveys in incidents with higher radiation levels. This especially becomes necessary in inaccessible terrain, for example when searching for a radioactive source in a scrap yard or inspecting buildings in nuclear installations.

The final demonstration of the ANCHORS system took place on April 18, 2015, with invited guests from public offices and institutions concerned with safety and security. The demonstration was held on Thyssen-Krupp premises in Dortmund, as part of a large-scale fire drill with 150 firefighters. Fraunhofer INT was closely involved in planning and implementing the demonstration of the system's use in an emergency.

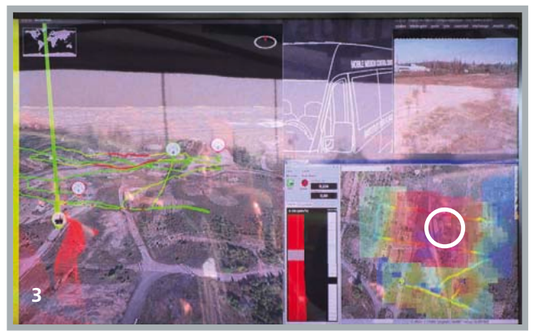
In the scenario, a team of workmen was using a radioactive source to investigate a leak in a pipe (see Figure 1). At the same time, a truck carrying dangerous chemicals was involved in a serious road accident nearby. A local firefighter team secured the accident area and treated the injured. The workmen, faced with the risk from the dangerous chemicals, panicked and fled the area. They left behind the radioactive source, but in a state that led to an increased local radiation level. The firefighters chose to use the ANCHORS system to gauge the situation, without having to get too close to the radioactive source.

First, an exclusion zone was set up; then the team moved the mobile ground station to the zone boundary. From the ground station, which served as takeoff and landing platform for the UAVs (see Figure 2), a UAV fitted with cameras was flown to a central position above the radiation source in order to provide

a picture of the situation. This UAV stayed in position while a second, fitted with a radioactivity sensor, was flown in. The second UAV followed a predetermined path that allowed the fastest and most effective search of the area, thus fixing the precise position of the source.

Figure 3 shows the measurement results on the system's desktop. The total provides an optical picture of the search zone, as well as two graphic displays from different perspectives, which also give the trajectories of the UAV carrying the radioactivity sensor. The trajectory color codes relate to the radiation levels. The green line shows the level of the natural background radiation, while the yellow, orange and red lines point up increased or highly-increased levels of radiation. It was thus possible to determine the position of the source and correctly identify it as Se-75 (radionuclide selenium-75).

Altogether, four UAVs were used in the demonstration, two of which were airborne at the same time. Battery power allowed enough UAV flying time for surveying an area of 10,000 m^2. Autonomous UAV landings on the ground station were not possible during the demonstration; instead the UAVs were landed manually. However, the autonomous function was successfully carried out before the end of the project. The Fire Brigade at the demonstration clearly approved of the system: the senior fire officer called for it to be used a second time, this time to obtain a clear picture of the chemical hazard from the road



accident. This second ANCHORS application was unplanned, but it showed that the system can be very well integrated into Fire Brigade command structures.

The demonstration was the first public use of the UAV "swarm" and landing platform. Hitherto, only single components had been used. As regards data recording and transfer, the system was satisfactory, with only the manual UAV landings calling for more time than foreseen. Successful automatic landing was finally demonstrated several months later, during a small exercise at KHG (Kerntechnische Hilfsdienst GmbH). On the whole, it was shown that the ANCHORS system could be used successfully in a realistic scenario, proving its suitability to support emergency forces effectively in an incident involving radioactive materials.

1 *A radionuclide selenium-75 source (red circle) in use for the symbolic investigation of a potential leak in a pipe.*

2 *The mobile ground station with takeoff and landing platforms for the UAVs. A UAV f itted with radioactive sensor (red circle) has just taken off.*

3 *The measuring program's desktop interface for radioactivity detectors fitted to two UAVs. Above right: the live camera shot; below right and left: graphic displays with color-coded UAV trajectories. Red lines show the area with highest radiation, giving the position of the source (white circle bottom right).*

BUSINESS UNIT “NUCLEAR SECURITY POLICY AND DETECTION TECHNIQUES“

Dr. Theo Köble

The Business Unit “Nuclear Security Policy and Detection Techniques (NSD)” conducts theoretical and experimental research in the areas of nuclear security policy and nuclear detection methods. Besides fundamental studies, research projects are carried out for industrial clients (nuclear research and nuclear engineering) and public authorities (mainly for emergency service and major research institutions). Furthermore, with basic funding from the German Federal Ministry of Defence (BMVg), the work in NSD deepens and expands the national capacity to judge nuclear and radiological weapons and associated asymmetrical threats. Projects are also carried out with the Bundeswehr Research Institute for Protective Technologies (WIS) in Munster.

NSD’s work is supported by its ultra-modern technical equipment. For simulating physical processes a Linux cluster with 64 processor cores is available. Besides coupled neutron and gamma transport calculations, e. g. for simulating detector spectra, NSD also performs coupled neutron and hydrodynamics calculations. The Business Unit operates several neutron generators (14 MeV and 2.5 MeV) and an isotope laboratory to carry out experiments. The isotope sources and experimental facilities are occasionally made available to external users for their own investigations. To operate the irradiation facilities safely and to be able to deal with numerous radioactive substances, INT has the appropriate radiation protection organization and a permit to work at external locations (e. g. research reactors, nuclear power plants). All experimental work is supported by a precision engineering workshop and an electronics laboratory.

NSD continuously pursued political and technological developments in particular with regard to nuclear disarmament and possible proliferation. These are especially analyzed with the focus on their physical and technical aspects. In particular, nuclear developments in Iran and North Korea were observed, analyzed and evaluated. As part of the collaboration in the ESARDA (European Safeguards Research and Development Association) Working Group on Verification Technologies and Methodologies (VTM), which is organized by the Non Proliferation and Nuclear Safeguards Unit at the Joint Research Centre (JRC) in Ispra, the Business Unit investigated developments in international disarmament agreements, including export controls and new safeguard technologies for the International Atomic Energy Agency (IAEA). Of special interest were the negotiations that culminated in the nuclear agreement with Iran.

NSD also participated in technical preparation work for the Comprehensive Nuclear-Test-Ban-Treaty CTBT. In this context, a paper was presented in June at the organization’s Science and Technology Conference in Vienna. The business Unit continued its regular participation at the annual conference in the USA of INMM, the US counterpart to ESARDA.

In September, the Business Unit staged the 7th Symposium “Nuclear and Radiological Threats – Technological Power of Judgment and Nuclear Security in Germany”, with many NSD staff attending. Held every two years, this symposium reviews the nation’s current knowledge status on the subject (see the separate article in this Report on page 39).

Using the DeGeN measurement vehicle, tests and qualification measurements were carried out at the WIS location in Munster in June. For the prevention or early disclosure of terrorist acts using nuclear or radioactive material, NSD investigated the latest measuring systems for the detection and non-destructive identification of such materials, with a view to the systems’ suitability for use on site.

NSD also continues its work as partner in several international projects dealing with CBRNE threats (Chemical, Biological, Radiological, Nuclear, Explosives) and countermeasures that deal with them. The Unit logically contributes its R and N expertise to the respective consortia concerned. The following introduces these projects in brief.

The Franco-German project ANCHORS (UAV Assisted Ad Hoc Networks for Crisis Management and Hostile Environment

Sensing) is aimed at developing a cooperating swarm of UAVs (unmanned aerial vehicles) and UGVs (unmanned ground vehicles) for obtaining a comprehensive situation picture of the hazards in case of disaster. An octocopter serving as a UAV will also detect radioactivity and be used as a relay station to ensure smooth communication. Using the Institute's radioactive and electromagnetic irradiation facilities, extensive tests were carried out on both UAV and radiation detector. The project culminated in a fully integrated, functioning model. A large-scale follow-on demonstration of the project in Dortmund presented the ANCHORS system in action in a realistic accident with radiation risk, as part of a major Fire Brigade exercise (see separate article on page 40).

The large EU demonstration project EDEN (end-user driven demo for CBRNE) has the goal of demonstrating a comprehensive system of measures against CBRNE attacks or accidents and their consequences. More than 30 partners from across the EU are involved in the project. NSD was also involved in the needs and gaps analyses of the end-users. These analyses incorporate the results of earlier EU projects, complemented with end-user workshops. The Business Unit also participated in the development of RN scenarios and in RN demonstrations. Under the aegis of INT, a demonstration on nuclear smuggling was staged at the home of the project partner ENEA in Frascati, Italy. ENEA itself mounted a demonstration on the subject "dirty bomb". The demonstrations aim at showing the effective interaction of the comprehensive system of measures against CBRNE attacks and accidents, and how gaps are closed by systems newly developed within the project (see separate article on page 45).

In the EU-Horizon 2020 project C-BORD (effective Container inspection at BORDer control points), the Institute and a variety of European partners are developing improved strategies and equipment for the efficient control of bulk goods carried in containers. For the primary and secondary inspection lines, various inspection systems are being developed, integrated into one single system and verified in field tests. This is taking account of requirements at major sea ports, as well as at smaller and medium-sized container terminals, as at inland ports, for example. Fraunhofer INT is taking part in several work packages, and is itself leading the work package on the detailed assessment of the technical solutions identified and of the whole system at the conclusion of the project.

In addition, in a project under the German support program for IAEA, the Business Unit undertook comparative measurements with multi-channel analyzers made available by IAEA, which also provided the detectors powered by the analyzers.

NSD is also involved in work on standards for radiation measurement devices, nationally in DIN/VDE, and internationally in the corresponding IEC body.

DEMONSTRATION OF TOOLS FOR CBRNE DETECTION UNDER THE EDEN PROJECT IN FRASCATI

Dr. Sebastian Chmel, Dr. Monika Risse

Fraunhofer INT is a project partner in the major European research project EDEN, in which 37 institutions and companies from 15 mostly European countries are collaborating. The project is funded under the European Union's Seventh Framework Program. EDEN is the acronym for **E**nduser driven **DE**mo for CBR**N**E which in turn stands for **C**hemical, **B**iological, **R**adiological, **N**uclear and **E**xplosive material that could be used or released in attacks or accidents. The project has the aim of demonstrating a comprehensive system of measures against such events, preventing them in advance or reducing their effects. In the project, various technical and methodological tools (measuring instruments, imaging processes, simulation programs, access to expertise, etc.) are incorporated into systems, developed, tested, and demonstrated in training scenarios.

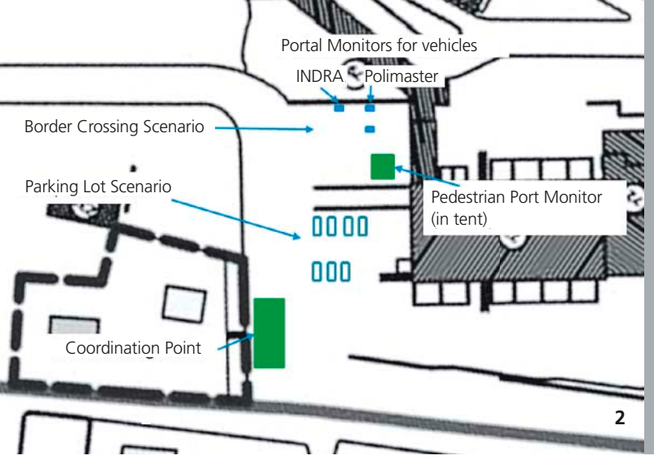
Initially, a needs analysis was conducted, together with a survey of how far these needs are already met by existing systems. This was partly done with recourse to results from previous EU projects such as DECOTESSC1, in which Fraunhofer INT was also involved. Under the EDEN project, INT's Business Unit NSD is currently continuing development of two tools that can be used in a radiological or nuclear (RN) event: the measuring vehicle DeGeN and the measurement container NaNu.

A demonstration for RN Tools was held from September 28 to September 30 on the premises of the Italian research center ENEA in Frascati. This demonstration included two themes: a smuggling scenario (RN4.1) and a scenario that dealt with a dirty bomb (RN4.2). INT's Business Unit NSD was tasked with planning and implementing RN4.1. This smuggling scenario was staged on September 30. Figure 1 shows the NSD staff who were on location in Frascati.

The smuggling scenario was made up of two parts. The first focused on detecting and identifying radioactive materials at a border station; the second was a covert search for such material in a parking lot. The tools applied were chosen in advance by using EDEN Store, an online platform that the project developed to provide selected users with structured access to information on relevant tools. As well as the project partners, non-participating producers of such systems also have the opportunity to present their tools. The EDEN Store will also be available beyond the project, at https://eden.astrium-eu-projects.eu/.

1 *NSD Team on location*

A total of 10 tools was used. For personal radiation protection, dosimeters (PM1703M0-1 from Polimaster) were issued to the participants. For the border station scenario, two portal monitors were used for vehicle control (the JANUS portal monitor from INDRA, and the Radiation portal monitor PM5000C-05M from Polimaster), as well as a portal monitor for checking people (Pedestrian portal monitor from Symetrica). Also used were two handheld devices (Hand Held from Symetrica and SPRD PM1704M from Polimaster). For the covert search scenario, an operation planning and monitoring system was used (Generic Ground Station – GGS, and First Responder Equipment – FR, from BAES). The search itself was conducted with the help of the measuring vehicle (DeGeN, from Fraunhofer INT) and a measurement backpack (Symetrica Backpack). Figure 2 is a map of the terrain where the demonstration took place. The upper area was the site for the border station scenario, the covert search zone is seen below. To simulate a parking lot, several cars were placed here (Figure 4).



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In order to assess the tools, it is of course necessary to test them under realistic conditions with real radioactive sources. For safety reasons, however, this meant the visitors who were to evaluate the devices were not allowed to go near the sources. The whole demonstration site was exclusively reserved for the technical teams. During the demonstration, the visitors stayed in a conference room. Over this distance, it was difficult to show the visitors in the conference room how the tools were performing. To overcome this, a host in the conference room led the visitors through the presentation, which was shown on three screens (see Figure 3). The first screen showed a live video transmission from the demonstration area, using an IP webcam and data transfer via WLAN. Figure 4 shows the cameraman in action filming the event, so the visitors can watch the users´ actions on site The center screen showed the live tool display, enabling the visitors in the conference room to watch the obtained measurement data in real time. Depending on the tool, different remote control programs were used. The host used the third screen for a PowerPoint presentation to take the visitors through the whole program. He briefly introduced the function and main tasks of each tool, as well as the type of data input. Subsequently, the corresponding part of the scenario was carried out on the demonstration location under live video transmission. This made it possible to observe the way measurement data developed. This approach was basically possible, because the players in the field were able to follow the conference room host all the time with the help of a conference net. On hearing a new catchword, they could move to the next step of the demonstration.

The WLAN transmission was a special challenge: since the demonstration was staged at ENEA in Italy and not at INT's home premises, an advance test had not been possible. The system had to be tested during preparation work on location in Italy, using ENEA infrastructure. Only then was it possible to test transmission of the other tools and their function for the foreseen scenarios. This was particularly challenging, because the last tool only arrived the day before the demonstration.

Thanks to direct transmission, the visitors were able to judge the quality of measurements from the situations shown. On all three days (see Figure 6), close observation of the tools and their function was possible, but without the sources having to be present.

All told, 110 participants from nine different countries attended. Because of the location, most participants came from Italy, but many also came from Germany, France, the United Kingdom, Lithuania, Poland, Spain, the Czech Republic and Hungary.

To take account of use by the end user, almost all tools were operated by NSD staff. The producers were largely in the conference room. Outside, an ENEA staff member placed a Co-60 source with an activity of 9 MBq, shielded in a lead container, in the trunk of a car. The dose rate at a distance of 1 meter was 200 nSv/h.

The first part of the demonstration was simulating a smuggling attempt at a border station. The prepared vehicle was driven past the measuring posts of the car portal monitors. Both portal monitors detected a source, and via the measurement signal observed over time, this was clearly attributed to the vehicle. Subsequently, the driver was instructed to leave the car, so that driver and vehicle could be separated and the source more clearly located. In the scenario, the driver attempted to disguise the source in the trunk with the aid of a medical radiation source. He maintained that the signal was caused by a radioiodine therapy recently carried out on himself. In the test, this was simulated with a weak Ba-133 source at the level of the neck. The person monitor alarm was triggered and – in contrast to the vehicle monitors – an identification could be gained and it proved to be correct. Even so, the driver was not simply waved through. Instead, the NSD staff acting as border control officers followed procedures and checked the vehicle using two handheld devices. These devices were the only ones for which there was no direct data transfer to the conference room, for which reason a further video transmission system was used. The two devices fulfilled the measurement tasks very well: the source concealed in the trunk was found and correctly identified.

5

2 *ENEA map view of the location for demonstration RN 4.1. The vehicles shown in this parking lot scenario are to scale.*

3 *Conference room with three screens. Screen 1 showed the live video transmission, screen 2 showed the tools display, and screen 3 showed the PowerPoint presentation.*

4 *ENEA parking lot. In the background, the tent with Pedestrian Portal Monitor.*

5 *Car with Co-60 source in the trunk passes both portal monitors: Left, a silver-colored post, the JANUS monitor from Indra. Right, two monitor pillars from Polimaster. The person is acting as a border guard.*

For the second part of the demonstration, the vehicle containing the source was parked in the prepared parking lot. The DeGeN search vehicle was used to conduct a search operation. Driving past, the DeGeN car recorded a very significant increase in measurement values on the side where the source car was standing. The measurement vehicle was then parked next to the source car, and an identification scan using the system's integrated germanium detector was started. Again, the correct nuclide Co-60 could be identified within a short time.

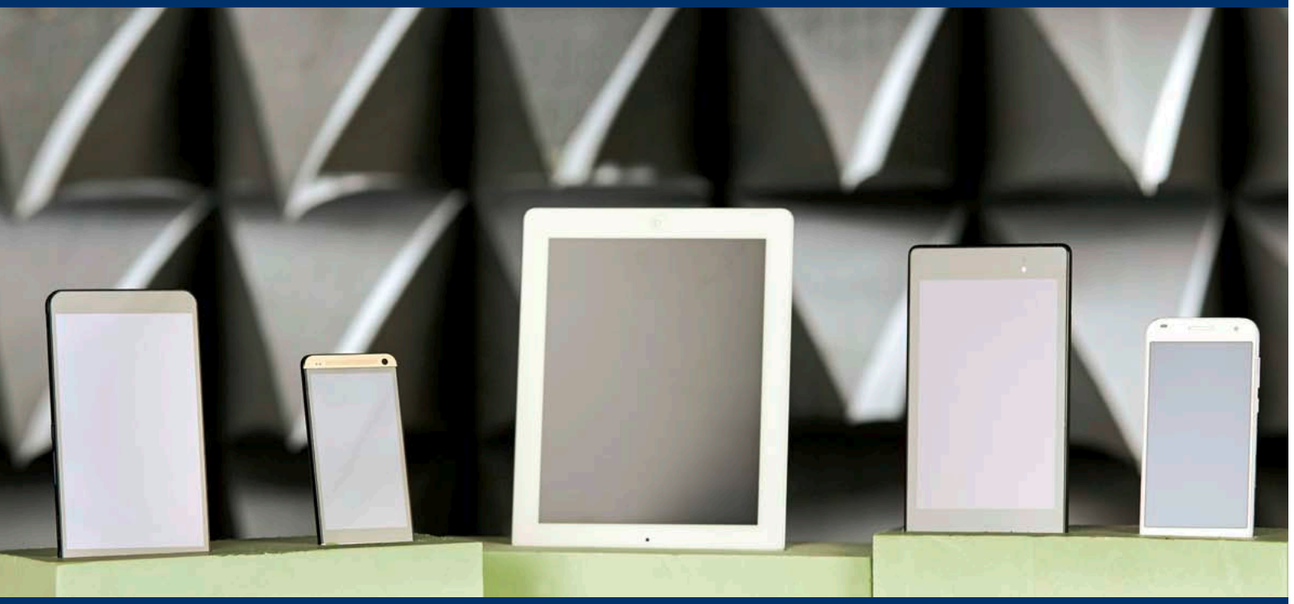
The last tool to be used to detect and identify the source on the parking lot was the backpack mentioned above containing a measuring system. Both detection and identification were demonstrated successfully. Before the search, the GGS system was used to define the backpack carrier's route. Also carried was an FR system that contained a personal dosimeter for tracking the carrier's exposure to radiation online.

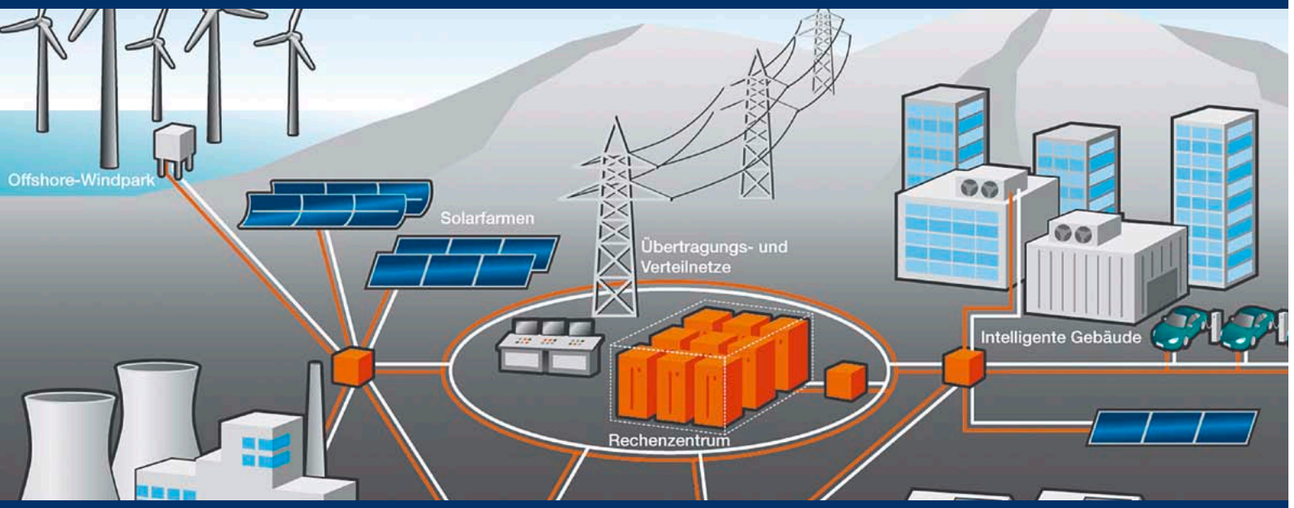
Feedback from the visitors was very positive. With the live video transmissions, the device displays and live presentation, they received a good impression of the functionality of the tools presented. Together with closer inspection of the tools after the demonstration (meanwhile without radioactive sources), a thorough evaluation of the individual systems and their interaction was achieved. It can overall be said that the demonstration was very successful for all participants.

6 *Demonstration schedule for all three days*

BUSINESS UNIT “ELECTROMAGNETIC EFFECTS AND THREATS“

Dr. Michael Suhrke





With basic funding from the German Federal Ministry of Defence (BMVg), this Business Unit has the task of contributing to the assessment of electromagnetic effects with regard to military threats. Since only the military sector only addresses this task to a given extent, EME conducts its own theoretical and experimental research – including further development in measurement technology – in consultation with BMVg and in cooperation with the defense industry. Over and above BMVg-funded research, contract research projects for clients outside the defense sector (civil security research) and projects for industry are becoming increasingly important.

The Unit’s experimental work on electromagnetic threats, especially high power microwaves (HPM), includes investigations into the coupling of electromagnetic fields in structures and specific systems, as well as studies on the vulnerability of electronics through high-intensity fields (High Power Electromagnetics, HPEM). The work ranges from IT equipment and systems based on current technology, and especially on wired and wireless data transmission technology (network engineering), to civilian communications and components of critical infrastructure. There is also basic research and experimental work on detection methods for electromagnetic threats, in particular from HPM.

The Unit has developed its own TEM waveguide (Transverse Electromagnetic Mode), which is housed in a shielded hall and covers the frequency range from 1 MHz to 8 GHz. This allows linear coupling measurement for determining transfer functions and studies on electromagnetic compatibility (EMC), as well as the investigation of interference susceptibility with constant and pulsed fields with strengths of up to several kV/m on objects up to several square meters in size. For measuring outside the Institute, the Business Unit has also developed its own mobile HPM irradiation facility, with which up to 5 kV/m can be generated by radiation using different antennas in field strength frequencies between 150 MHz and 3.4 GHz. These systems are complemented by a reverberation chamber fitted with high-energy sources for generating field strengths above 10 kV/m over frequencies from 500 MHz to 18 GHz to reflect the growing number of applications of modern sensor and communication technology in the higher gigahertz range, as well as a small anechoic chamber to 40 GHz and extensive radio frequency and microwave measurement instruments.

Part of the research carried out for BMVg in 2015 included further development work on an HPM detector – a commission from the Bundeswehr Research Institute for Protective Technologies (WIS) in Munster. There were also investigations into generation dependency regarding HPEM vulnerability in electronics. A measuring campaign at WIS Munster also investigated HPEM coupling into buildings. In addition, concept work was concluded on the NATO STO SCI-294 Task Group “Demonstration and research of effects of RF Directed Energy Weapons on electronically controlled vehicles, vessels and UAVs”, due to commence in 2016.

In civil security research, the Unit was also active in the EU Commission’s 7th Framework Program for Security Research (FP7) on the “Protection of Critical Infrastructures against High Power Microwave Threats”. The Unit acted under the leadership of Norway’s Defence Research Establishment (FFI) as partner in the HIPOW Consortium, which ended at the beginning of 2016. In this context, laboratory tests on the HPM sensitivity of critical infrastructure components were concluded in 2015. The work was presented in contributions to the 2015 EMC Europe Conference in Dresden and to Future Security 2015 in Berlin. Also presented at EMC Europe were studies on the EMC resistance of Unmanned Aerial Vehicles (UAVs) under the BMBF project “UAV Assisted Ad Hoc Networks for Crisis Management and Hostile Environment Sensing ANCHORS”, (see article on the final demonstration for the ANCHORS project on page 40).

EME is also widely active in standardization. This includes the DIN working groups “TEM Waveguide and Reverb Chamber” and “EMC Semiconductors”, the VG (German defense equipment) standard boards on NEMP and lightning protection, and

on electromagnetic compatibility. The Unit is also national representative in the IEC's Joint Working Group Reverberation Chamber. The NATO STO SCI-250 Task Group "Radio Frequency Directed Energy Weapons in Tactical Scenarios" developed a concept for a NATO standard on HPEM immunity tests, which was subsequently published within NATO. Further development of HPEM standardization is also to be the subject for the follow-up NATO STO SCI-294 Task Group. As part of the development work on the corresponding IEC standard, tests on the statistical evaluation of the TEM waveguide were carried out jointly with the Leibnitz University, Hanover. The results were presented at EMC 2015, in Dresden.

Again in 2015, the threat from high power microwaves was the subject of external presentations, for example at the conference Directed Energy Systems 2015 in London.

And also in 2015, work began at EME on a doctorate on the subject "HPEM vulnerability of the Smart Grid".

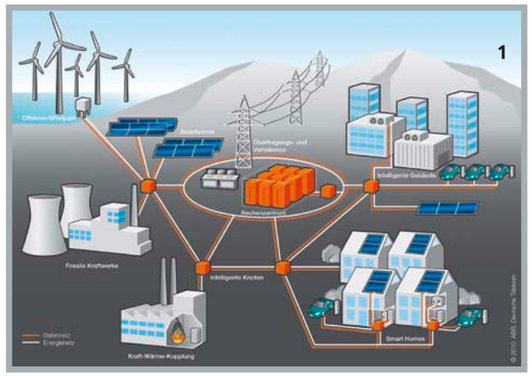
HPM-VULNERABILITY STUDIES ON SMART ELECTRIC METERS

Marian Lanzrath

A solid power supply with little downtime is a matter of course in Germany. However, with the increasing role of electronic equipment in support of everyday processes, our social system is also susceptible to power supply failures. Even today, many systems such as food storage, POS or ATM, communications and entertainments media, or medical care, become unusable when power is down. To ensure tomorrow's energy supply, Germany is going through an energy revolution. The aim is to convert energy production from limited quantities of fossil fuels to sustainable, renewable sources.

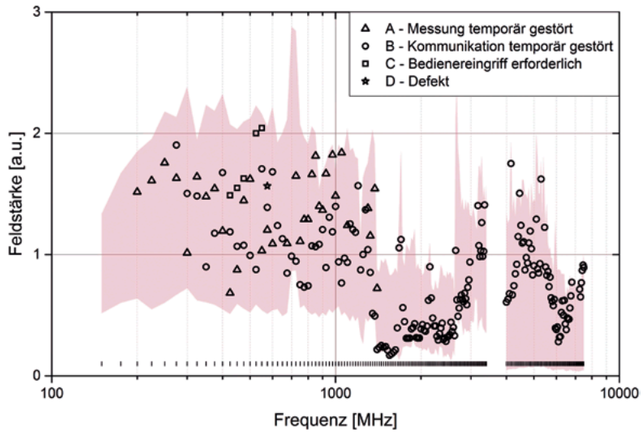
Currently more than 50 % of electricity is generated in large, centralized power plants, mainly using nuclear, gas, lignite and anthracite power. However, the intention is to replace these with renewable generators, such as photovoltaic and wind plants. The required amount of renewable energy sources can nonetheless only be provided by spreading generators over a large area. Power is generated by a number of different-sized solar plants on private homes, industrial buildings and farms, or by large solar or wind farms (see Figure 1).

A solid power supply requires a control system that secures a balance between consumption and generation on the grid at any time. This is necessary for Germany and the entire European grid, to ensure the frequency and voltage stability that is essential for safe operation by electricity consumers. Currently, production is adapted to the consumption requirement by controlling the power plants. To this end, a power requirement roadmap for sluggish power stations is drawn up on the basis of demand forecasts. Deviation from the consumption forecast is compensated through energy held in reserve. However, this system is not applicable in the case of renewable energy, since generation depends on the weather – which does not allow reliable prediction. With the increased use of renewable generation facilities, it can already be observed that at certain times the current no longer flows from 380 kV transmission grid to 20 kV distribution grid, but instead the distribution grid feeds the current back into the transmission grid, which makes controlling the grid difficult. To achieve the energy turnaround, there is an increased need for long-term energy storage and a control system, which together offset the differences between fluctuating weather-dependent generation and power consumption.



A new control thus needs to be established in order to minimize the expansion of expensive energy reserves and energy storage. Conceivable could be what is known as Demand-Side Management (DSM). Here, uncritical power consumers such as heating, cooling or compressed air devices with integrated energy storage, or those instruments with variable running time (tumble dryer, dishwasher, washing machine) are shifted from times of increased energy demand (peak load) to a later, low-load period. For reliable regulation, DSM requires real-time data regarding the power grid. This can be provided by a modern measuring and communication network with appropriate data processing capacity (Figure 1). One component of the measure-

1 *Smart Grid Structure with networked components (Fig; http://www04.abb.com/global/seitp/seitp202.nsf/e308f3e92d9a8fc5c1257c9f00349c99/0c299eef3acc286bc1257705003 88dd9/$FILE/SmartGrid_Ueberblick_ohne Legende.jpg)*



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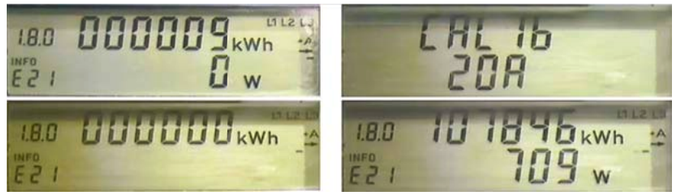

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ment system is the intelligent electricity meter, or smart meter. These are electricity utility meters that can transmit data to the utility via interface. This makes high demands on data protection, to shield the system and sensitive customer data against theft and hacking.

Modern electronic devices are often highly susceptible to electromagnetic interference. In standards for electromagnetic compatibility (EMC), field strength limits for susceptibility and radiated emissions from the devices are defined, so that they do not interfere with each other during operation. Where electromagnetic signals with field strengths above standard limits are used to disrupt electronics intentionally, this is called Intentional Electromagnetic Interference – IEMI. An interesting question that the Business Unit EME (Electromagnetic Effects and Threats) is currently dealing with at Fraunhofer INT, is the influence on the power grid, and thus on Germany's power supply, from pulsed high frequency signals of high field strength. Smart meters underwent initial tests in the laboratory. The meters are an easily accessible target for attackers and are therefore suitable as a starting point for this complex subject.

Tests on the meters were conducted in the INT waveguide. Different meter models with test frequencies up to the gigahertz range were tested. Field strengths were up to three orders of magnitude above the required EMC standard limits. Figure 2 shows the result diagram of a test series.

In testing, various error images became apparent: Figure 3 shows a few examples. Frequently, measurement was temporarily affected during testing, so that the meters measured too little or too much consumption. Moreover, the meter readings were also often changed. Detected were meter reading jumps down to 0 kWh or up to more than 100 000 kWh. Other temporary errors during testing were display and communication failures, and meter restarts. The test revealed even permanent damage, with permanent measurement deviations, segment failures in the display, damage to communications technology, and total meter failure. Examples of total failure were meters being locked in a start routine or failing to show an error.

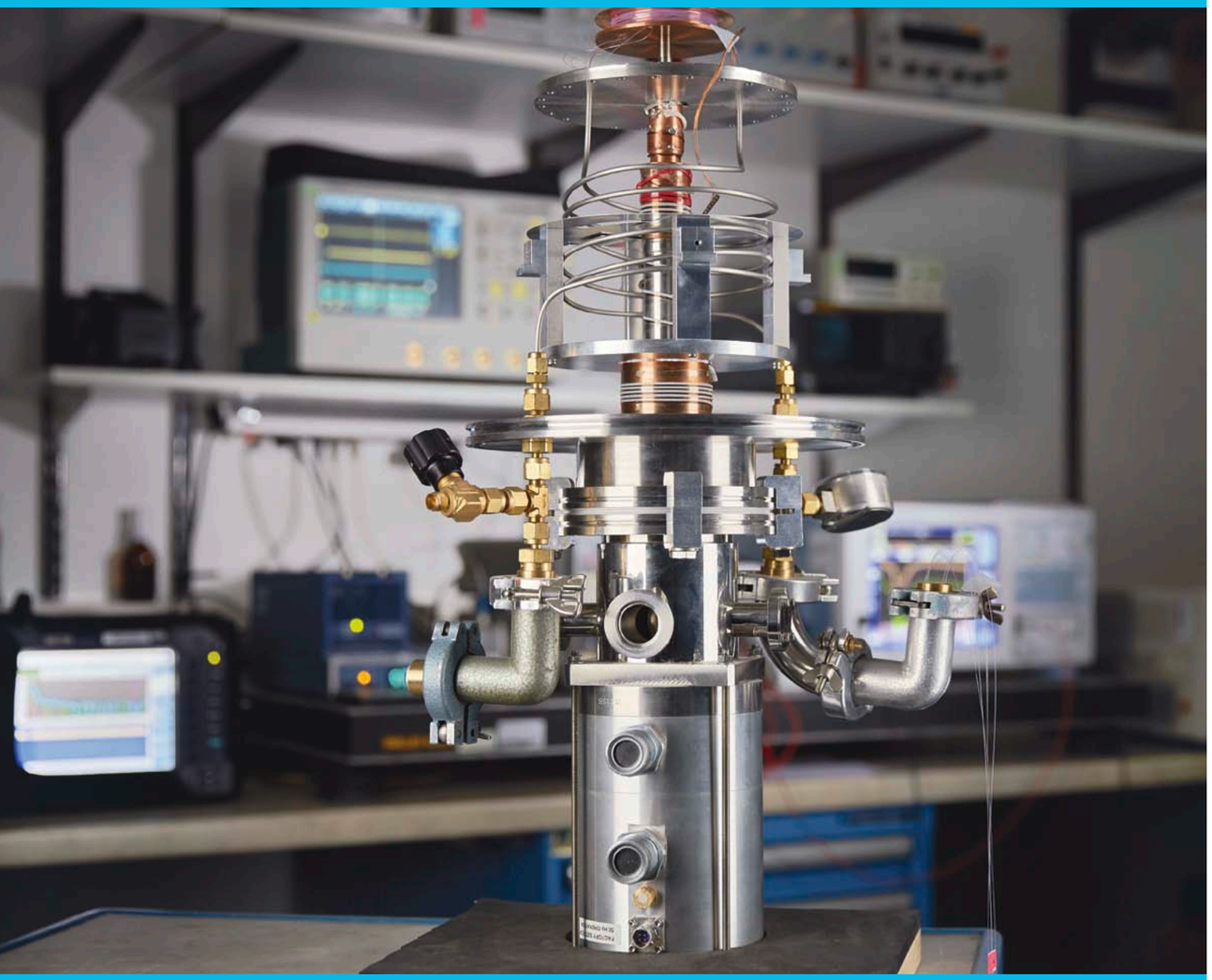
One conclusion of these tests is that the meters are very sensitive to high frequency fields. The errors detected were found in the whole frequency range and with various coupling methods and models. Frequently, there was permanent damage, which called for meters to be replaced. Owing to the abrupt changes in meter readings and the high deviation in measurement, the meters appear to be very unreliable and do not make for a trustworthy energy consumption display. Meter manipulation has no effect on the power supply, since the proportion of single meters within the whole system is minimal and the data is currently only used for billing purposes. However, these devices provide only the final link in a complex hierarchy of networked systems, which in view of the present results should be examined even more critically with regard to its immunity to interference radiation.

2 *Chart showing the default thresholds observed and defect image classification for the smart meters tested*

3 *Meter displays showing various faults during testing*

BUSINESS UNIT “NUCLEAR EFFECTS IN ELECTRONICS AND OPTICS“

Dr. Jochen Kuhnhenn



Fraunhofer INT’s Business Unit NEO is specialized in the effects of ionizing radiation on electronic, optoelectronic and optical components and systems. NEO conducts these radiation tests in accordance with international standards and advises companies in radiation qualification and hardening, for example for satellites or accelerators. This experience is also used for the development of novel radiation sensors. Radiation tests are mainly carried out in INT’s own facilities, although external facilities are also used. The set of radiation facilities at INT is unique in Europe. They make it possible to recreate in the laboratory all radiation types and the effects they induce – relevant for satellites for example. In addition, NEO has the latest available technology for measuring even the smallest changes in characteristic parameters.

By continuing the new strategy, NEO is also especially forging progress by widening competence in Single Event Effects (SEE). This objective is in particular derived from the ever-increasing sensitivity of digital electronic systems and power electronics to the penetration with single charged particles. Hitherto, these cause malfunction or failure, particularly in space applications or high-energy accelerators. Yet even in airplanes or sensitive ground systems, cosmic radiation creates more and more challenges for manufacturers and users. This area brings with it new and scientifically exacting tasks for NEO. In this particular context, 2015 saw the first irradiation campaigns conducted at the COSY accelerator at the research center Forschungszentrum Jülich.

To achieve this goal, new academic staff was taken on, and the Unit’s technical equipment was extended. In cooperation with longstanding partners, NEO is establishing itself in the SEE sector, initially in space and accelerator applications, also to meet the demands of other markets in the medium term.

10 years of well-established cooperation between NEO and the European nuclear research center CERN were achieved in 2015, and this is being continued. During the year under review, the focus was again on glass fiber studies, as well as on the effects on electrical components, systems and materials. These experiments were carried out both at home on NEO’s own Co-60 irradiation facilities and neutron generators, as well as on external high-dose irradiation plants.

A patent application submitted in 2013 for the secure erasure of data on flash data memories passed examination by the International Patent Office in 2015. This will now be applied in national patents in various regions of the world. First talks with potential partners for exploiting and marketing have already taken place. Further details on the methods developed are to be found in a separate presentation in this Annual Report (page 59).

Following the founding of the Fraunhofer Space Alliance, a number of events brought the participating institutes together in 2015, with NEO taking part as well. Several of last year’s events showed how effectively competences have complemented each other, and how the perception of individual Alliance institutions could be improved. In 2016, NEO as part of the Space Alliance will again be present at the ILA Berlin Air Show, as well as at the International Conference on Space Optics (ICSO). Fraunhofer INT will be responsible as technical chair for the upcoming RADECS conference, which will take place in Germany for the first time.

Although current reconstruction work on laboratory facilities has greatly limited radiation tests, work has been carried out on more projects than ever before. In parallel in two of the three Co-60 radiation facilities, new sources with fully characterized radiation fields were installed, now making about twice and five times respectively the dose rate available. By taking on new staff, project work capacity has been adjusted to meet the increasing demand in recent years.

NEO continued to participate in various tenders for the European Space Agency. Four projects have been won, and work is currently proceeding on them. This includes developing and investigating novel concepts for shielding against electromag-

netic and ionizing radiation, reducing shield weight but having the same protective efficiency.

To promote the next generation of scientists, NEO is actively involved in their education. In this context, 2015 saw the conclusion of a joint bachelor degree project of NEO and the RheinAhrCampus at Koblenz University, which studied the influence of the sample preparation of optical fibers on light transmission and radiation sensitivity. NEO is also supporting a doctoral thesis at CERN, in the field of radiation sensors with optical fibers.

ERASING A NONVOLATILE SEMICONDUCTOR MEMORY WITH IONIZING RADIATION

Dr. Jochen Kuhnhenn

State of the Art

A variety of data (secret documents, personal data, sensitive corporate data, etc.) must be reliably deleted after retention periods expire or before the media are disposed of, in order to meet legal requirements or to prevent an undesired spread of data.

There are currently three commercially-used methods for securely eliminating stored information (over and above the inefficient use of erasure software):

1. mechanically shredding media
2. degaussing magnetic media
3. thermal destruction (exceeding Curie temperature)

The most commonly used method for electronic memories (DIN 66399, class E) is the first, whereby differing security levels depend on the size of particles produced. It should be noted that currently available NAND flash memory chips of e. g. 128 GB now reach storage densities greater than 1 GB per mm², so that today, with the right devices or methods, intact data volumes in the order of gigabytes are readable on even the smallest fragments after shredding (See Fig. 1).

Effects of ionizing radiation in flash memories

All flash memories are based on storing charges in what is called a floating gate. This is a MOSFET with an additional gate which is completely surrounded by insulator material (hence the name floating gate). If, for example, electrons are injected into the floating gate (FG), they protect the field adjacent to the control gate (CG), which causes a shift of the characteristics of the MOSFET. If a defined voltage is applied to the CG, no current will flow between source (S) and drain (D), while a detectable current flows in an erased cell. The programming of the cell (injection of the electrons) works either by the electrons skipping the potential barrier of the insulator ("hot channel injection", commonly used in NOR Flash), or by tunneling through the potential barrier ("Fowler-Nordheim tunneling", commonly used in NAND Flash), by applying respectively appropriate (high) voltages. Deletion is generally electrical via Fowler-Nordheim tunneling. If no voltage is present, the charge remains trapped in the floating gate until it escapes through smallest leakage currents in the insulator within 10 to 100 years.

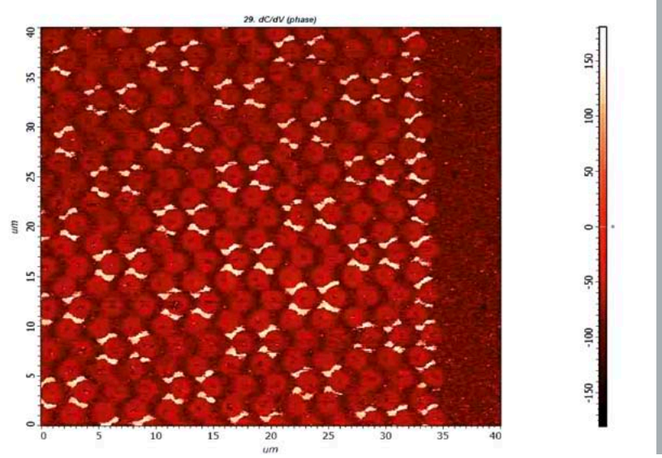
Ionizing radiation on the memory cells of a floating gate memory has three basic effects:

1. Electrical charges are generated in the insulator surrounding the floating gate. The charges penetrate the FG and neutralize the stored charge.
2. Photoemission: the charges in the FG obtain enough energy from ionizing radiation to overcome the insulator's potential barrier.
3. A portion of the charge in the insulators is trapped on site. Compared with the first two effects, this portion is relatively small because of the fine thickness of the insulator layers.

Ultimately, ionizing radiation causes a discharge of each FG, and, as from irradiation with a correspondingly high dose, leads to the complete neutralization of all stored electrons. This results in the reliable, complete and irrevocable destruction of information, regardless of its initial state. The result is comparable to the degaussing of magnetic disks.

Description of method

This new method makes possible the complete and irreversible deletion of data on all types of semiconductor-based memory, regardless of the size or initial state of the memory. The devices do not need to be opened for the purpose, and it is not necessary to remove batteries from mobile devices in advance. It is also unnecessary for the memory or device to be functional,



1

as is the case with software-based data erasure. The devices are simply exposed to ionizing radiation. The type and energy of ionizing radiation is selected so that the housing of the device is penetrated and the memories within are sufficiently irradiated. Through the effects described above, ionizing radiation causes a continuous reduction of the stored charge. After a given dose, no further charges are present in the memory cells and the data is completely erased.

With this method, it is also possible for the device to remain within sealed, secured outer packaging during the entire erasure process – because ionizing radiation penetrates both packaging and device housing. After the process, the devices remain as good as intact (there will be some changes in plastics used). They are thus available for subsequent forensic analysis (e. g. verification). The process irreparably damages existing electronic components, and after erasure, the device is no longer usable. However, as the device is not physically destroyed, conditions for recycling are ideal. Valuable raw materials can be fed into the secondary circuit and re-used. The fact that the device is inoperable makes data erasure even more secure.

A patent for the method has been applied under DE 10 2013 214 214.

1 *Illustration of a publication for reading bit information from a destroyed flash memory (from DOI: 10.1117/12.2017156). Color contrasting indicates areas with stored "1" or "0" information.*

SCIENTIFIC-TECHNICAL SUPPORT

Peter Clemens

The Department Nuclear and Electromagnetic Effects (NE), has an extensive scientific-technical infrastructure that supports experimental work in its three Business Units. Belonging to this infrastructure is a precision engineering workshop which makes special mechanical parts for experimental apparatus, and an electronics workshop which produces specific electronics for experiment work and carries out servicing and repairs.

The Department also has its own secretariat. The following is a selective overview of the tasks performed:

Precision-engineering laboratory

- Tailored assemblies and setup modifications for experiments, e. g. improvements on cryostat for low temperature investigations of optical fibers
- Radio frequency probes used for shielding effectiveness of housings
- Special mountings and fastenings for irradiation work
- Shielded housings for radio frequency applications
- Preparing platforms for presentations and exhibitions

Electronics laboratory

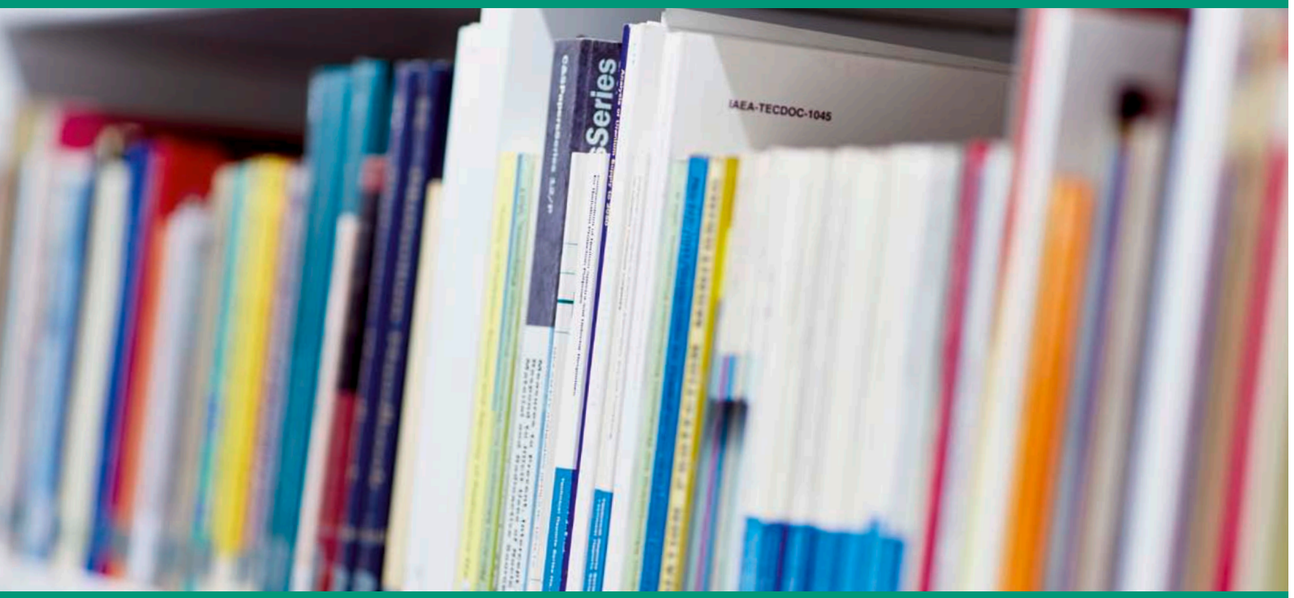
- Providing extensive support for all fields in preparing and conducting experimental work
- Manufacturing of devices, e.g. hardware development for EU-HPM-Detector
- Repairing of devices, e.g. repairing of TWT-amplifier
- Developing irradiation and measuring boards
- Servicing and operating the neutron generators for irradiation projects
- Operating the measuring computer network
- Consulting in the planning of INT's new buildings
- Work safety, fire protection and office technology
- Hosting 4 scientific assistants
- Hosting 4 school-age trainees (from 1 to 2 weeks)

Secretariat

- Formatting and producing posters
- Providing organizational support for projects
- Formatting study reports, radiation protection documentation
- Preparing and drafting EU project applications (e. g. Framework Programme 7)
- Preparing and hosting workshops

BUSINESS ADMINISTRATION AND CENTRAL SERVICES

Prof. Dr. Harald Wirtz



Business Administration and Central Services is the department responsible for all commercial and administrative tasks in the Institute. As well as providing the central infrastructure, department staff is also responsible for a number of employer functions, such as workplace safety and security.

The Department subdivides into Finance, Human Resources and Law (FPR), and Central Infrastructure (ZI). In addition, the sectors Library, Security, Marketing, and PR operate independently.

With the departure of Waltraud Rasmussen and Wilfried Gericke, the two deputy department head positions were left vacant. From summer 2015, these positions were taken by Sabrina Langemann, Head of Finance, Personnel and Legal Affairs, and Udo Rector, Head of Central Infrastructure.

The group **Finance, Human Resources and Law** is responsible for book-keeping, accounting, controlling, human resources and travel management. **Book-keeping** is conducted in accordance with German commercial and tax law. The area also handles the purchase of all consumer items and investment goods, in compliance with purchase guidelines and the official German terms for awarding service and construction contracts (VOL/VOB). The department also manages the INT cash office, handling all cash and non-cash payments.

Controlling covers all monetary processes within Fraunhofer INT, which includes the continuous supervision and control of the Institute's entire budget. There is also administrative support for project budgets in other departments. Since sponsors continuously conduct internal and external audits of the Institute, the department also deals with all audit inquiries.

Human Resources supports the Institute's management in personnel planning, and processes all personnel tasks such as job advertising, hiring, job evaluations and resultant income-group classification, as well as contract extenuation. **Travel management** assists staff on every aspect of official travel, covering planning and preparation, transport and hotel bookings, and travel expense accounting in accordance with Federal Law.

Central Infrastructure is responsible for Facility Management / Internal Services and Central IT Services. Facility Management continues to play an important role in coordinating the various construction projects on the premises. **Central IT Services** covers the Institute's entire IT infrastructure, providing first level support for the users.

The Central IT Services section is also intensively involved in preparing and implementing the project for the application of IT-based assistance systems for technology foresight (see also below, or report on page 22) and "Rahs". It advises and supports the Department TASP in procurement questions and operates the requisite IT components.

Marketing and Public Relations does all the necessary communications and marketing work for results produced by INT's individual business units.

Predominant tasks of the **Library and Specialized Information Service** are procuring and managing the media that the Institute requires, and supporting the scientists in research and accessing information. Depending on project needs, further specialized databases and other information sources are licensed and made available. The library also trains media and information specialists in information and documentation work.

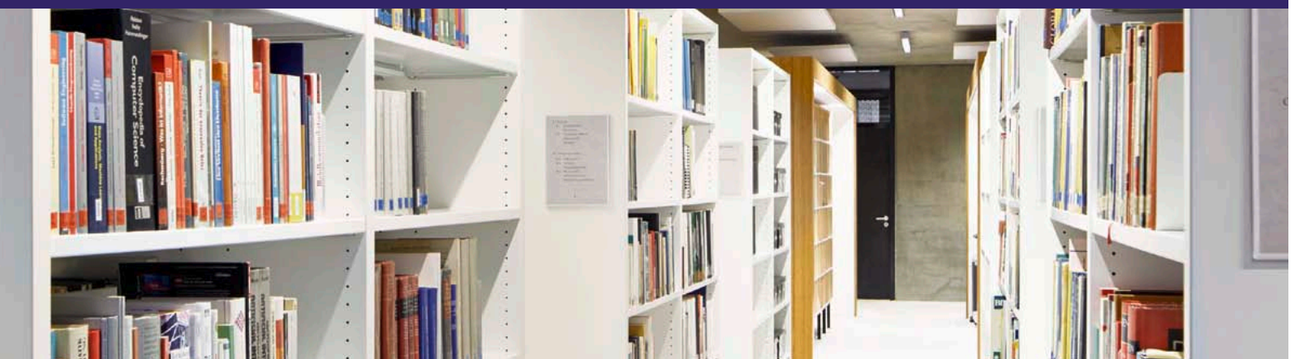
The Section was involved in work packages (3 and 4) of the project for the application of IT-based assistance systems for technology foresight, whose tasks include suitability analyses of cognitive systems for technology foresight. Since 2015, the Section's technical information has also regularly been used to identify and develop wider ranges of specialist IT and data-based methods and tools relevant to INT.

BUILDING PROJECTS

Building Projects

In the reporting year were also realized some building projects. Besides the initial commissioning of the seminar room and the library (compare INT annual report 2014) the constructions continued in form of the addition of one floor to the office block, the new walkway to the older building of the institute and the new canteen. A commissioning of these objects in 2016 seems to be realistic. In addition, the rebuilding of the laboratory has been carried forth.

OTHERS



SPACE ALLIANCE 2015

Thomas Loosen

There were two dominant trends for the second year of the Fraunhofer Space Alliance: increased internal networking among the member institutes and greater external Alliance awareness within the national and international space community.

The trends were evidenced by a workshop with participants from the INNOSPACE program organized under the German National Aeronautics and Space Research Centre DLR. The workshop, held in Euskirchen on February 5, was a joint platform for the Alliance Institutes and DLR to generate ideas for technology transfer projects suited for promotion by INNOSPACE or other programs.

The first event with an external impact was the 4th German National Conference on Satellite Communication, staged in Bonn from March 23 – 25. Above all, Fraunhofer IIS was prominent because of its work in on-board electronics, while other Alliance activities also won the public's attention at the demonstration stand. The public itself was primarily made up of key actors in Germany's space research and aerospace industry.

Additionally, a creative workshop in Darmstadt addressed internal networking, with participants coming exclusively from the Alliance and the Fraunhofer Gesellschaft headquarters. Project ideas from earlier workshops were consolidated and ideas for new projects were worked on, all with the intention of bringing together the highly-varied expertise in the individual institutes for the benefit of the whole.

In October, the Alliance took to the international stage, with five institutes presenting themselves to the global space community at the International Astronautical Conference 2015 in Jerusalem. The Fraunhofer Gesellschaft's liaison office in Israel helped to set up several highly interesting meetings with Israeli industrialists and the public sector.

There was also participation in Space Tech Expo, a meeting for the space industry staged in Bremen in November. Being held in Europe for the first time, the elaborately-mounted joint stand was exceptionally well received. A highlight at the stand was an IOSB robot, which independently conducted real-time reflectance measurements on various surfaces.

The Alliance rounded off the year 2015 with the annual meeting in early December in Berlin. The events of the year were reviewed and assessed, and first plans for 2016 took shape.

STAFF POSITION METHODS AND TRAINING AND CHAIR RWTH AACHEN UNIVERSITY

Dr. Birgit Weimert, Stephanie Hansen-Casteel

Together with specialist and procedural expertise, methodological skills are a major building block of competent technology analysis and forecasting. For this reason, the Staff Position "Methods and Training" was set up as a Competence Center already in 2013, and tasked with promoting method development and evaluation – the sustainable development of Fraunhofer INT's methodological expertise. Taking account of the area's importance, a complementary support group called "Tools and Methods" was established in spring 2016 within the Department Technology Analysis and Strategic Planning TASP.

Working out and maintaining a comprehensive overview of the methods landscape, continuously updating methods and process knowledge, and our own research activities in the field are among the Staff Position's core tasks. Over and above this, the Position again supported INT management with successful strategic acquisitions, through conceptualizing and establishing cross-institute project applications, through conducting and participating in projects, and by providing INT management with scientific advice. The Staff Position continues its function as point of contact for the "Institute for Technology Analysis and Foresight in Security Research" at RWTH University, Aachen.

Under the Staff Position's leadership, INT experts last year developed the strategic orientation for IT and data-based methods, linking set targets by providing optimum support for Fraunhofer INT's various Business Units.

The Serious Gaming Framework developed by the Staff Position was published and peer-reviewed in a scientific journal last year. After successful trademark registration, Fraunhofer INT is offering this format as a service package under the name FlexINT®.

At RWTH University in Aachen, work regarding course content and methodology for the Chair of the "Institute for Technology Analysis and Foresight in Security Research" was also successively pursued. The purpose of the Chair is to provide university students with quantitative and qualitative future research methods in the context of application-oriented teaching and learning concepts. Looking at future research from the aspects of suitability and optimization, this includes both the epistemological underpinning of methods and the examination of the methods spectrum. The Chair focuses on analyzing forecasting processes in technology, as well as on the adaptation, development and improvement of appropriate procedures and methods. Continuously generated research findings support scientific decision-making in technology as it evolves in the course of time.

The Chair recorded an increase in student numbers for the period under review. In the Winter Semester 2015/2016, the attendance figure for the lecture "Methods of Future Research 1 (MdZF1)" was 140 students.

Another major success in 2015 was the content and method concept for an interdisciplinary seminar, to be held in 2016 for the first time. The seminar will be conducted by the incumbent Chair, Prof. Dr. Dr. Michael Lauster, together with Prof. Dr. Dr. Axel Zweck (Sociology Chair at RWTH University Aachen). The basic concept is for students of engineering to collaborate with sociology students on the subject of technology assessment. The purpose is to analyze the different perspectives of the two academic disciplines. The students in the interdisciplinary team will have the opportunity of developing specific tasks, thereby using the most important methods and instruments of technology assessment in the process. The seminar is titled "(Inter)Disciplinary Future – Tomorrow's Technologies from the Social and Engineering Science Views". The concluding event is scheduled for July 2016, at Fraunhofer INT in Euskirchen.

An additional highlight in 2015 was the series of lectures held in conjunction with the Ravensburg-Weingarten University. This brought 32 students from the university's Technology Management Faculty to INT to attend the lectures on "Methods of Future Research". Conducted by Prof. Lauster, and with contributions from the TASP Department, the event was held in the new seminar building in Euskirchen from May 27 – 29, 2015. The students welcomed the lectures as a useful addition and diversification. Further lecture series are already in process. Prof. Lauster is also supervising a doctoral thesis on "Technology Acceptance", which has the objective of developing an indicator toolkit for the prospective measuring of technology acceptance by potential users.

MISCELLANEOUS

DWT CBRN Exhibition

From 19 to 21 October, the Research Association of the German Association for Defence Technology (Deutsche Gesellschaft für Wehrtechnik mbH – DWT), staged the 3rd International Symposium on Development of Chemical, Biological, Radiological and Nuclear (CBRN) Defence Capabilities. CBRN aspects considered were: the threat, prevention of use, and possible defensive measures.

Fraunhofer INT was represented by the Business Unit NSD. As well as mounting an information stand and giving a talk during the conference, NSD also presented the measurement vehicle DeGeN. Taking place on October 19 in Berlin's Julius Leber Barracks, this was part of a dynamic demonstration of NBC defense capabilities under the leadership of the Bundeswehr CBRN Command, and of a static display of military, civil and industrial capabilities.

The demonstration was also visited by Ambassador Ahmet Üzümcü, the Director-General of the Organization for the Prohibition of Chemical Weapons, OPCW, which was awarded the Nobel Peace Prize in 2014. The photo shows Mr. Üzümcü discussing details of the measurement vehicle with NSD staff.

futurelab (2): „Social Machines“

Fraunhofer INT and foresightlab stage futurelab, a series of events that focuses on the process of digital transformation. The aim of the Labs is to provide foresight analyses of disruptive developments and their impact on business and society, and to provide players with innovative formats enabling them to participate actively in the change."

In cooperation with Z_punkt, an international consulting company for strategic future issues, INT again hosted a half-day future workshop in Cologne, on November 11, 2015.

Together with participants from various sectors, Klaus Burmeister from Z_punkt and Dr. Martin Brüchert from INT's Business Unit CTF discussed the theme "Social Machines". The following questions were central: how does digital transformation change the individual customer interface? What applications exist already in the present (Best Practice)? What customized applications are possible with new human-computer interfaces? What technologies are driving development forward? How does the potential of data-based value growth change the ways of existing business models?

The prime target for this interactive futurelab are companies that wants to prepare for digital transformation changes well in advance.

Driver: I4CM Workshop in Berlin

The "International Workshop on Innovation for Crisis Management" (I4CM) was held in Berlin from 8 to 9 December. The workshop is an important element of the project DRIVER (Driving Innovation in Crisis Management for European Resilience), the largest EU-funded research project on crisis management. The event was opened by Albrecht Broemme, President of the "Technisches Hilfswerk" (THW), Federal Agency for Technical Relief, and Prof. Dr. Alfred Gossner, member of the Executive Board, Fraunhofer Gesellschaft.

The session, held under the title "Innovation for Crisis Management" (I4CM), was attended by experts and organizations from all over Europe. I4CM offers a platform for exchange between crisis response players on the one hand, and the scientific Crisis Management Community on the other. The unanimous opinion in lectures, panel discussion, during breaks and the evening reception was that this exchange happens too seldom and calls for greater intensity.

APPENDIX

University Courses, Lectures and Exercises

Burbiel, J., Jovanović, M.: "Errors to avoid in HORIZON 2020" as part of the course programme of the European Police College (CEPOL), Münster-Hiltrup, 1/20/2015

Chmel, S.: Lecture and exercise "Physics"in the Bachelor's course Naturwissenschaftliche Forensik (2nd semester) at the Bonn-Rhein-Sieg University of Applied Sciences, Sankt Augustin, summer term 2015

Chmel, S.: Lecture "Wahrnehmung von Wissenschaft in der Gesellschaft" as part of the Master´s course Technik- und Innovationskommunikation, Module "Technik, Politik und Gesellschaft", Bonn-Rhein-Sieg University of Applied Sciences, Sankt Augustin, 6 / 25/2015

Chmel, S.: Lecture and exercise "Measuring Techniques" in the Bachelor's course Naturwissenschaftliche Forensik (3rd semester) at the Bonn-Rhein-Sieg University of Applied Sciences, Sankt Augustin, winter term 2015/2016

Grüne, M.: "Nanotechnologie – Nanochemie – Nanokohlenstoff", teaching unit within the basic class on chemistry, EF grade, Marienschule Euskirchen, 2/11/2015

Grüne, M.: "Zur Wissenschaftlichkeit der Zukunftsforschung"; residential course "Methods of Futures Research" within the masters programme "Technologiemanagement" of Hochschule Ravensburg-Weingarten, Fraunhofer Institute of Technological Trend Analysis (INT), Euskirchen, 5/27/2015

Grüne, M.: "Wehrtechnische Zukunftsanalyse Robotik"; Führungsakademie der Bundeswehr, Module 2013 "Integrierte Planung für die Bundeswehr– Methodik der Zukunftsanalyse", Hamburg, 11/24/2015

John, M.: "Leben und Arbeiten mit dem Cochlea Implantat – Funktionsweise, Chancen, Risiken und Erfahrungen im Hinblick auf die medizinische Rehabilitation" – Module as part of the Advanced Course of Rehabilitation Medicine of the Academy of Social Medicine, Berlin, 1/26/2015

John, M.: "Die Technisierung des Menschen – Über Cochlea Implantate, Cyborgs und Human Enhancement" – presentation as part of the lecture "Technik und Gesellschaft – Umwelt und Gesellschaft" at the Bonn-Rhein-Sieg University of Applied Sciences, Sankt Augustin, summer term 2015, 4/8/2015

John, M.: "Das Cochlea Implantat im Spannungsfeld von Technik und Kultur – Die Kontroverse um das Cochlea Implantat" – presentation as part of the lecture series "Technik- und Umweltethik" at the Bonn-Rhein-Sieg University of Applied Sciences, Sankt Augustin, 4/16/2015

John, M.: "Bibliometrie für die Technologiefrühaufklärung. Eine Einführung unter besonderer Berücksichtigung der Intelligenten Recherche" – presentation as part of the lecture "Methoden der Zukunftsforschung" for the University of Applied Sciences Ravensburg-Weingarten, 5/25/2015

Jovanović, M.: Seminar "Aufbauseminar Informetrie" in the Bachelor's courses Informationswissenschaft, Heinrich Heine University Düsseldorf, summer term 2015

Jovanović, M.: Seminar "Projektmanagement" in the Bachelor's and Master´s courses Informationswissenschaft, Heinrich Heine University Düsseldorf, winter term 2014/2015

Jovanović, M.: "Wissenschaftliche Recherche am Beispiel bibliometrischer Analysen", presentation as part of the seminar "Technik und wissenschaftlicher Wandel" by Prof. Dr. Wiemken, Bonn-Rhein-Sieg University of Applied Sciences, Sankt Augustin, 4/1/2015

Jovanović, M.: "Bibliometrische Analysen als Instrument wissenschaftlicher Analysen", presentation as part of the seminar "Technik und wissenschaftlicher Wandel" by Prof. Dr. Wiemken, Bonn-Rhein-Sieg University of Applied Sciences, Sankt Augustin, 6/23/2015

Kohlhoff, J.: Lecture and exercise on the subject "Elektromobilität" as part of the seminar "Technik/Umwelt und Gesellschaft", Bonn-Rhein-Sieg University of Applied Sciences, Sankt Augustin, 4/29/2015 and 5/20/2015

Kohlhoff, J.: Exercise on the subject "Autonome Systeme" as part of the seminar "Technik/Umwelt und Gesellschaft", Bonn-Rhein-Sieg University of Applied Sciences, Sankt Augustin, 17/6/2015

Kohlhoff, J., Reschke, S.: Seminar "Methoden der Zukunftsforschung" as part of the Master´s course "Technologiemanagement", University of Applied Sciences Ravensburg-Weingarten, Weingarten, 30/6/2015 – 7/2/2015

Lauster, M.: "Methoden der Zukunftsforschung I", RWTH Aachen University, winter term 2014/2015 and winter term 2015/2016

Lauster, M.: "Methoden der Zukunftsforschung II", RWTH Aachen University, summer term 2015

Lauster, M.: "Methoden der Zukunftsforschung", University of Applied Sciences Ravensburg-Weingarten, summer term 2015

Pastuszka, H.-M.: Lecture "Wehrtechnische Zukunftsanalyse", course module "Methoden der Zukunftsanalyse", Führungsakademie der Bundeswehr Hamburg, 24/11/2015

Wiemken, U.: Lecture/Seminar Bachelor's course Technikjournalismus, module "Technik und Gesellschaft", Bonn-Rhein-Sieg University of Applied Sciences, Sankt Augustin, summer term 2015

Wiemken, U.: Lecture/Seminar Master's course Technik- und Innovationskommunikation, module "Technik und Gesellschaft", Bonn-Rhein-Sieg University of Applied Sciences, Sankt Augustin, summer term 2015

Wirtz, H.: "Prozessmanagement" – Change/Innovation, Hochschule Fresenius, Cologne, summer term 2015

Wirtz, H.: "Change- und Innovationsmanagement", Hochschule Fresenius, Cologne, winter term 2014/2015, summer term 2015, winter term 2015/2016

Wirtz, H.: "Finanzierung", Hochschule Fresenius, Cologne, winter term 2014/2015, summer term 2015, winter term 2015/2016

Wirtz, H.: "Investitionsrechnung", Hochschule Fresenius, Cologne, winter term 2014/2015, summer term 2015, winter term 2015/2016

International Cooperation

Adami, C., Joester, M., Pusch, T., Ruge, S., Suhrke, M., Taenzer, H.-J.: EU-FP7-Projekt HIPOW (Protection of Critical Infrastructure against High Power Microwave Threats), 14 project partners

Baum, M., Höffgen, S., Kuhnhenn, J., Kündgen, T., Lennartz, W., Metzger, S., Paschkowski, E., Schmitz, S., Steffens, M., Weinand, U., Wolf, R.: CERN, Geneva, Swiss

Berky, W., Chmel, S., Friedrich, H., Köble, T., Risse, M., Rosenstock, W.; Schumann, O.: Project ANCHORS (UAV-Assisted Ad Hoc Networks for Crisis Management and Hostile Environment Sensing), Collaboration with French partners, May 2012 – April 2015

Berky, W., Chmel, S., Friedrich, H., Glabian, J., Köble, T., Ossowski, S., Risse, M., Schumann, O.: FP7 Project EDEN (End-user Driven Demo for CBRNE), 38 project partners, September 2013 – August 2016

Berky, W., Chmel, S., Friedrich, H., Lieder, E.: H2020 Project C-BORD (Effective Container Inspection at BORDer Control Points), 18 project partners, June 2015 – November 2018

Burbiel, J., Jovanović, M.: Agreement with the General Directorate migration and home affairs for impact assessment, evaluation and services related to evaluation in the fields migration and home policy; 8 partners, term October 2015 – September 2017

Burbiel, J., Grigoleit, S.: Direction of the work package 6 „Elaboration of a research agenda" in the FP7 security research project CARONTE (Creating an Agenda for Research on Transportation Security); 12 projekt partners, term of the work package November 2015 – February 2016

Grigoleit, S.: EU-FP7 Project SOURCE (Virtual centre of excellence for research support and coordination on societal security), 11 project partners

Höffgen, S., Kuhnhenn, J., Weinand, U.: KIC Project HOBAN, France

Höffgen, S., Kuhnhenn, J., Kündgen, T., Lennartz, W., Metzger, S., Paschkowski, E., Steffens, M.: ESA-ESTEC, Noordwijk, the Netherlands

Jovanović, M., Burbiel, J.: Coordination of the FP7 security research project EvoCS (The evolving concept of security: A critical evaluation across four dimensions); 9 project partners, term June 2014 - November 2015

Kuhnhenn, J., Metzger, S., Steffens, M.: Seibersdorf Labor GmbH, Seibersdorf, Austria

Lieberz, D., Linde-Frech, I., Löscher, M., Missoweit, M., Vollmer, M., Walther, G.: EU-FP7 project DRIVER (Driving Innovation in Crisis Management for European Resilience), 36 project partners

Missoweit, M.: Scientific direction DRIVER demonstration project

Ossowski, S., Risse, M., Schumann, O.: Comparative Testing: MCA-527 versus MCA-166, IAEA, Vienna, Austria

Pastuszka, H.-M., Römer, S.: Critical Technologies Working Group, European Defence Agency (EDA), 1/21/2015 and 10/07/2015

Pastuszka, H.-M.: Technology Watch Workshops, European Defence Agency (EDA), 04/14/2015 and 10/06/2015

Reschke, S.: TNO Soesterberg, NL

International Reviews

Burbiel, J.: RSC Advances

Burbiel, J.: Tetrahedron Letters

Grüne, M.: Programme Committee, Future Security, 10th Security Research Conference, Berlin 2015

Höffgen, S., Kuhnhenn, J.: IEEE Transactions on Nuclear Science

Höffgen, S., Kuhnhenn, J.: RADECS 2015 Conference

Jovanović, M.: Scientometrics

Jovanović, M.: ASLIB Journal of Information Management

Jovanović, M.: Science and Public Policy

Jovanović, M. (Guest Editor): EvoCS Special Issue „Information & Security"

Jovanović, M.: ISSI Konferenz 2015

Kuhnhenn, J.: Journal of Non-Crystalline Solids

Lubkowski, G.: Progress in Electromagnetics Research (PIER)

Metzger, S.: Nuclear Instruments and Methods in Physics Research A, Elsevier

Missoweit, M.: EU 7th Framework Programme Projekt-Reviewer

Missoweit, M.: Member Advisory Board H2020 Project PANDEM (Pandemic Risk and Emergency Management)

Suhrke, M.: IEEE Transactions on Electromagnetic Compatibility

Thorleuchter, D.: Technological Forecasting and Social Change

Thorleuchter, D.: Electronic Commerce Research and Applications

Thorleuchter, D.: Information Sciences

Thorleuchter, D.: Engineering Applications of Artificial Intelligence

Thorleuchter, D.: Advances in Engineering: an International Journal

Thorleuchter, D.: Abstract and Applied Analysis

Thorleuchter, D.: Journal of Information Systems Engineering & Management

Thorleuchter, D.: International Journal of Library Science

Collaboration in Committees

Burbiel, J.: Ethical Advisory Board of the EDEN project

Chmel, S.: Coordination of AG "Antrags- und Projekt-management", Fraunhofer EU-Network

Hecht-Veenhuis, S.: Berufsbildungsausschuss NRW, subcom-mittee "Geprüfter Fachwirt / Geprüfte Fachwirtin für Medien- und Informationsdienste in NRW"

Metzger, S.: Awards Committee at RADECS 2015 in Moskow, Russia

Metzger, S: Organisation Committee of RADECS 2016 in Bremen, Germany (as Technical Chairman)

Missoweit, M.: H2020 Security Advisory Group

Missoweit, M.: H2020 Advisory Group on Gender

Missoweit, M.: H2020 Advisory Group on International Cooperation (Co-Chair)

Missoweit, M.: European Organisation of Security (EOS), Board of Directors

Missoweit, M.: European Association of RTOs (EARTO), Security Working Group (Co-Chair)

Thorleuchter, D.: Spokesman of the Fachgruppe Betrieb von Informations- und Kommunikationssystemen der Gesellschaft für Informatik e.V. (GI)

Thorleuchter, D.: Editorial Board of the International Journal of Information Science

Thorleuchter, D.: Editorial Board of the Journal of Advanced Computer Science & Technology

Thorleuchter, D.: Editorial Board of the International Journal of Digital Contents and Applications

Thorleuchter, D.: Journal of Information Systems Engineering & Management

Thorleuchter, D.: Advances in Engineering: an International Journal

Thorleuchter, D.: Program Commitee WorldCIST'15: 2015 World Conference on Information Systems and Technologies, Azoren, Portugal, April 01 – 03, 2015

Wiemken, U,: panelists of the 6th expert workshop White Paper 2016, "Veränderung und Wandel in Deutschland: Implikationen für die Bundeswehr", Berlin, 9/03/2015

Participation in Norming Processes

Adami, C.:NA140-00-19AA, creation of VG-Normen VG96900-96907, NEMP- und Blitzschutz.

Adami, C.: NA140-00-20-02UA, creation of VG-Normen VG95370 ff., Elektromagnetische Verträglichkeit.

Adami, C.: NATO HPM Standardization (NATO STO SCI-250 Task Group)

Jöster, M.: DKE / AK 767.13.5, EMV von Halbleitern, DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE

Köble, T.: DIN and VDE DKE/GUK 967.2, "Aktivitätsmessgeräte für den Strahlenschutz"

Köble, T.: IEC/SC 45B WG 15, "Radiation protection instru-mentation" – "Illicit trafficking control instrumentation using spectrometry, personal electronic dosimeter and portable dose rate instrumentation"

Suhrke, M.: National Representative Joint Task Force Reverberation Chamber of IEC

Suhrke, M.: GAK 767.3/4.4, TEM-Wellenleiter und Reverberation Chamber, DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE

Lectures and Presentation

Baum, M.:
"Dosis- und Struktureffekte in Siliziumhalbleitern", Workshop Herausforderung Weltraum, Euskirchen, 11/11/2015

Brüchert, M.:
"Neue Technologien, neue Möglichkeiten – Die technologische Zukunft als Impuls", Workshop "Industrie 4.0", Euskirchen, 1/27/2015

Brüchert, M., Reschke, S.:
"Industrie 4.0 – Ein Blick in die technologische Zukunft als Impuls", TÜV Rheinland Industrie Service, Ahrweiler, 3/12/2015

Brüchert, M., Reschke, S.:
"Industrie 4.0 – Ein Blick in die technologische Zukunft als Impuls", TÜV Rheinland Industrie Service, Kick-Off Talent Team, Odenthal, 3/23/2015

Brüchert, M.:
"Maschine(n) der Zukunft – Auf dem Weg zur intelligenten Maschine durch Industrie 4.0?", Belfor DeHaDe Schaden-forum, Hamm, 6/25/2015

Brüchert, M.:
"Maschine(n) der Zukunft – Auf dem Weg zur intelligenten Maschine durch Industrie 4.0?", Belfor DeHaDe Maschinen-forum, Hamm, 6/26/2015

Brüchert, M., Suwelack, K.U.:
"Die Future-Technology-Check-Methode – Technologievoraus-schau für kleine und mittlere Unternehmen", symposium for foresight and technology planning, Berlin, 10/29/2015

Brüchert, M.:
"Techtrends 2025+: Welche Technologietrends beeinflussen Social Machines?", FutureLab #02, Köln, 11/11/2015

Brüchert, M.:
"Maschine und Mensch in der Industrie 4.0 und 5.0 – Auf dem Weg zur intelligenten Maschine?", Wirtschaftsverband für Industrieservice e. V., Jahresabschlusstreffen, 12/03/2015

Höffgen, S.:
"Einzelteilcheneffekte in Siliziumhalbleitern", Workshop Herausforderung Weltraum, Euskirchen, 11/11/2015

Höffgen, S.:
"Strahlungseffekte in Materialien und optischen Komponenten", Workshop Herausforderung Weltraum, Euskirchen, 11/12/2015

Höffgen, S.:
"Strahlungseffekte in Verbindungshalbleitern", Workshop Herausforderung Weltraum, Euskirchen, 11/12/2015

Huppertz, G.:
"UCAV – Unmanned combat aerial vehicles. Technologische Möglichkeiten und Trends", Luftmachtseminar 2015, Führungsakademie der Bundeswehr, Hamburg, 5/18/2015

Joester, M.:
HPM detector system with frequency identification, Hazards-Detection and Management, Dresden, 9/01/2015

John, M., Fritsche, F.:
"Bibliometrics for Technology Forecasting and Assessment – Further Results and Future Prospects" – Lecture at the 2nd European TA Conference "The Next Horizon of Technology Assessment", Berlin, February 25 – 27, 2015

John, M.:
"Bibliometric-Based Visualizations and Maps for Technology Foresight" – Invited lecture at the annual meeting of the European Academy "Planning, Prediction, Scenarios – Using Simulations and Maps", Bonn, May 11 – 12, 2015

John, M.:
"Quantitative Methoden der Zukunftsforschung am Beispiel der Bibliometrie", Lecture at FüAkBw-Seminar-Modul "Methoden der ZukA", Hamburg, 11/25/2015

Jovanović, M.:
"Scientific cooperation in the republics of former Yugoslavia before, during and after the Yugoslav wars", ISSI Konferenz, Istanbul/Turkey, 7/01/2015

Jovanović, M.:
"The vicious circle of evaluation transparency - an ignition paper", ISSI Konferenz, Istanbul/Türkey, 7/02/2015

Jovanović, M.:
"Understanding the Public Security Discourse- an Attempt by the Evocs Project", NATO Academic Konferenz, Bertinoro/Italy, 10/05/2015

Köble, T.:
Determination of Uranium enrichment with FRAM – comparison of electrically cooled Germanium detector Detective200 and U-Pu detector, ESARDA 37th Annual Meeting Proceedings, Manchester, Great Britain, May 19 – 21, 2015

Kuhnhenn, J.:
"Fibre Optic Radiation Sensor Systems for Particle Accelerators" (FTh4E-6), Frontiers in Optics, San Jose, USA, 10/22/2015

Lauster, M.:
"Vorstellung des INT", Visit MdL Klocke, Euskirchen, 1/21/2015

Lauster, M.:
INNOspace Transfer Workshop with DLR, Darmstadt, 2/05/2015

Lauster, M.:
AI Research and Lethal Autonomous Systems, AA Berlin, 2/23/2015

Lauster, M.:
Panelist at the discussion "Geoinformation und Satelliten-navigation – kritische Infrastrukturen der Zukunft?", ESOG/CESAH Darmstadt, 4/23/2015

Lauster, M.:
"Prognosen" Common Event by IHK Aachen and Fraunhofer INT, Euskirchen, 4/29/2015

Lauster, M.:
"Botschaft der Forschung", Strategy Group of the Research Director BMVg, Bonn, 5/12/2015

Lauster, M.:
Presentation of INT and Alliance Space in the Austrian Federal Ministry for National Defence and Sport, Vienna, 10/28/2015

Lauster, M.:
"Technologievorausschau – Zukunftswissen oder Spekulation?", Rheinmetall, Bonn, 11/5/2015

Lauster, M.:
"Dynamik der Entwicklung bei Wehrmaterialien – Ausgewählte Aspekte, Fakten und Wertungen", GKS-Akademie Fulda, 11/11/2015

Lauster, M.:
Presentation of Alliance Space and INT in the Combined Air Operations Centre Uedem, 12/10/2015

Metzger, S.:
"Investigating Proton Induced SEE in Modern Microelectronics @ COSY", COSY Beam Time Advisory Committee (CBAC), Jülich, 6/29/2015

Missoweit, M.:
Moderation of the Session "Crisis Management". 10th Fraunhofer Future Security Conference. Berlin, Germany, September 15 – 17, 2015.

Missoweit, M.:
Science-based disaster management – Advancing disaster management through scientific support. Panel discussion. European Civil Protection Forum 2015. May 6 – 7, 2015 (invited).

Missoweit, M.:
DRIVER - DRiving InnoVation in crisis management for European Resilience. DG HOME Community of Users (CoU) Event. Brussels, Belgium. May 4 – 5, 2015.

Neupert, U., Römer, S.:
"Disruptive Technology Assessment Gaming - ein militärisches Table-top-Game zur Technologiebewertung -", Führungsakademie der Bundeswehr (FüAkBw) Seminar Module "Methoden der ZukA", Hamburg, 11/25/2015

Neupert, U., Huppertz, G., Nätzker, W.:
"Abwehr von Minidrohnen" (sUAS), Klausur meeting „Nah- und Nächstbereichsschutz" (NNbS), Cologne/Wahn, 10/13/2015

Pastuszka, H.-M., Römer, S.:
"(25) Vermeidbare Fehler in Horizont 2020– Initiierung, Durchführung und Abwicklung von Forschungsprojekten in Horizont 2020", conference of the key contact persons for Security Research, January 28 – 29, 2015 at the DHPol, Münster, 1/29/2015

Pusch, T.:
Vulnerability of Personal Radiation Meters to Intentional Electromagnetic Interference, round table, Euskirchen, 4/16/2015

Pusch, T.:
HPEM Vulnerability of Radiation Meters Used in Security Relevant Scenarios, EMC-Europe 2015, Dresden, 8/20/2015

Pusch, T.:
Generation Dependence of Communication Device Vulnerability to IEMI, Future Security 2015, Berlin, 9/16/2015

Reschke, S.:
Industrie 4.0: Interaktives Erarbeiten neuer Optionen für Procurement und (S)SCM am Beispiel disruptiver Elemente. Lecture, RKW Hessen; AG Einkauf und Beschaffung, Kelsterbach, 06/17/2015

Reschke, S.:
Industrie 4.0: Eine subjektive interaktive Einführung. Hochschule Ravensburg-Weingarten, Weingarten, 6/30/2015

Reschke, S., Brüchert, M., Suwelack, K.-U.:
Technology Foresight at Fraunhofer INT. Institut für Lebensmittel- und Ressourcenökonomik, University Bonn, Bonn, 10/15/2015

Reschke, S., Fritsche, F., John, M., Weimert, B., Jovanović, J.:
Anticipation: A bibliometric approach to its connotation, context, and transitions in peer reviewed publications from 1974 to 2014. First International Conference on ANTICIPATION, Trento, Italy, November 05 – 07, 2015

Risse, M.:
Car-borne search and identification measurements with Detective 200 devices, 56th Annual Meeting INMM, Indian Wells, USA, July 12 – 16, 2015

Risse, M.:
Car-borne measurements of radioactive material, 3rd International Symposium on Development of CBRN Defence Capabilities, Berlin, October 19 – 21, 2015

Rosenstock, W.:
Nuclear Disarmament – Technical Means for Verification, DPG Arbeitsgruppe Physik und Abrüstung (AGA), Berlin, March 15 – 20, 2015

Rosenstock, W.:
Nukleare Abrüstung – Technische Möglichkeiten zur Verifikation vor Ort, 7. Symposium Nukleare und radiologische Bedrohungen, Euskirchen, September 08 – 10, 2015

Schumann, O.:
Analysis of the IAEA reports about the Iranian nuclear program, DPG Arbeitsgruppe Physik und Abrüstung (AGA), Berlin, March 15 – 20, 2015

Steffens, M.:
"Strahlung im Weltraum", Workshop Herausforderung Weltraum, Euskirchen, 11/11/2015

Steffens, M.:
„Strahlungsabschirmung", Workshop Herausforderung Weltraum, Euskirchen, 11/11/2015

Suhrke, M.:
HPEM Susceptibility of Electronic Equipment and Critical Infrastructures, Directed Energy Systems 2015, London, 2/12/2015

Suhrke, M.
A Detailed Study on TEM Waveguides' Field Distribution and Efficiency, EMC-Europe 2015, Dresden, 8/20/2015

Thorleuchter, D.:
Priorisierung im Rahmen der Rüstungsabschirmung, Treffen der AG Rüstungsabschirmung, Euskirchen, 5/29/2015

Vollmer, M.:
"Analysing organisational, legal, and political framework conditions to support the implementation of new crisis management solutions", Future Security Conference 2015, Berlin, 9/15/2015

Wiemken, U.:
"Anmerkungen zur Wehrtechnik und zu ihrer ethischen Bewertung im Wandel der Zeit", lecture series Technology and Environmental Ethics, Bonn-Rhein-Sieg University of Applied Sciences, Sankt-Augustin, summer term 2015, 5/28/2015

Wiemken, U.:
"Sieben Thesen zum Weißbuch 2016 unter dem Blickwinkel von Naturwissenschaft und Technik – Implikationen für Gesellschaft und Bundeswehr", Führungsakademie der Bundeswehr, Hamburg, 12/15/2015

Publications

Adami, C.; Chmel, S.; Jöster, M.; Pusch, T.; Suhrke, M.:
Define and test electromagnetic immunity of UAS for first responders: Presentation held at EMC 2015, Dresden, August 16 – 22, 2015 (International Symposium on Electromagnetic Compatibility (EMC) <2015, Dresden>) 2015
URN urn:nbn:de:0011-n-3743298

Adami, C.; Chmel, S.; Jöster, M.; Pusch, T.; Suhrke, M.:
Definition and test of the electromagnetic immunity of UAS for first responders (Kleinheubacher Tagung <2015, Miltenberg>)
In: Advances in radio science. Online journal, Vol.13 (2015), pp.141-147, DOI doi:10.5194/ars-13-141-2015

Adami, C.; Jöster, M.; Pusch, T.; Suhrke, M.; Taenzer, A.:
Generation dependence of communication device vulnerability to intentional electromagnetic interference (IEMI) (Security Research Conference "Future Security" <10, 2015, Berlin>)
In: Beyerer, Jürgen (Ed.) et al.: 10th Future Security 2015. Security Research Conference. Proceedings: September 15 –17, 2015, Berlin. Stuttgart: Fraunhofer Verlag, 2015, pp. 347-354, URN urn:nbn:de:0011-n-3643498

Adami, C.; Berky, W.; Jöster, M.; Pusch, T.; Suhrke, M.:
HPEM vulnerability of radiation meters used in security relevant scenarios (International Symposium on Electromagnetic Compatibility (EMC) <2015, Dresden>)
In: Institute of Electrical and Electronics Engineers -IEEE-: IEEE International Symposium on Electromagnetic Compatibility, EMC 2015. Vol.2: Joint conference with EMC Europe; Dresden, Germany, 16 - 22 August 2015. Piscataway, NJ: IEEE, 2015, pp.1068-1072, DOI 10.1109/ISEMC.2015.7256316

Adami, C.; Braun, C.; Clemens, P.; Jöster, M.; Ruge, S.; Suhrke, M.; Schmidt, H. U.; Taenzer, H.-J.:
HPM detector system with frequency identification: Presentation held at International Conference, 10 years IGRS, 8th Dresden Symposium, Hazards - Detection and Management, August 31 – September 04, 2015 in Dresden, Germany (International Geo-Hazards Research Society (IGRS International Conference) <2015, Dresden>), 2015
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Alia, R.G.; Bahamonde, C.; Brandenburg, S.; Brugger, M.; Daly, E.; Ferlet-Cavrois, V.; Gaillard, R.; Hoeffgen, S.; Menicucci, A.; Metzger, S.; Zadeh, A.; Muschitiello, M.; Noordeh, E.; Santin, G.:
Sub-LET threshold SEE cross section dependency with ion energy
In: IEEE Transactions on Nuclear Science, Vol.62 (2015), No.6, pp.2797-2806, DOI 10.1109/TNS.2015.2483021

Baum, M.; Komarek, A.C.; Holbein, S.; Fernández-Díaz, M.T.; André, G.; Hiess, A.; Sidis, Y.; Steffens, P.; Becker, P.; Bohatý, L.; Braden, M.:
Magnetic structure and multiferroic coupling in pyroxene $NaFeSi_2O_6$
In: Physical Review. B, Vol.91 (2015), No.21, Art. 214415, pp.11, DOI 10.1103/PhysRevB.91.214415

Brandt, H.; Langner, R.:
Structural health monitoring
In: Europäische Sicherheit & Technik: ES & T, Vol.64 (2015), No.7, pp.65

Brüchert, M.; Suwelack, K.:
Die Future-Technology-Check-Methode – Technologievorausschau für kleine und mittlere Unternehmen (Symposium für Vorausschau und Technologieplanung <11, 2015, Berlin>)
In: Gausemeier, Jürgen (Ed.): Vorausschau und Technologieplanung. 11. Symposium für Vorausschau und Technologieplanung 2015: October 29 – 30, 2015, Berlin. Paderborn: HNI, 2015. (HNI-Verlagsschriftenreihe 347), pp. 205-218

Burbiel, J. C.:
Primary prevention of posttraumatic stress disorder: Drugs and implications. Review
In: Military medical research : MMR, Vol.2 (2015), No.1, Art.24, pp.7, DOI 10.1186/s40779-015-0053-2

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SCINTILLA – a European project for nuclear security (Security Research Conference "Future Security" <10, 2015, Berlin>)
In: Beyerer, Jürgen (Ed.) et al.: 10th Future Security 2015. Security Research Conference. Proceedings: September 15 – 17, 2015, Berlin. Stuttgart: Fraunhofer Verlag, 2015, pp. 481-483, URN urn:nbn:de:0011-n-3644289, URN urn:nbn:de:0011-n-364428-10

Chmutina, K.; Jovanović, M.; Bosher, L.; Dainty, A.; Burbiel, J.:
The complexity of security dimensions: A comparison of the North-West and South-East European regions (Security Research Conference "Future Security" <10, 2015, Berlin>)
In: Beyerer, Jürgen (Ed.) et al.: 10th Future Security 2015. Security Research Conference. Proceedings: September 15 – 17, 2015, Berlin. Stuttgart: Fraunhofer Verlag, 2015, pp.169-176, URN urn:nbn:de:0011-n-3643483

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Freudendahl, D.; Reschke, Stefan; Langner, R.:
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In: Werkstoffe in der Fertigung, (2015), No.5, pp.3

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Werkstofftrends: Electronic skin
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Grigoleit, S.; Burbiel, J.:
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Other Events

January 01, 2015
EvoCS Regional Case study Information Session: Grand Hotel, Sofia, Bulgaria

January 27, 2015
EvoCS Regional Workshop on South-Eastern Europe:
Grand Hotel, Sofia, Bulgaria

March 17 – 18, 2015
Exibition booth: DLR Bauteilekonferenz bei OHB System AG, Munich

July 01, 2015
Exibition booth: 2nd Konferenz- and Workshop Day „Strategische Vorausschau in der Praxis", Bundesakademie für Sicherheitspolitik, Berlin

September 05, 2015
Exibition booth: Open Day Mercator-Kaserne, Euskirchen

September 08 – 10, 2015
7. Symposium Nukleare und radiologische Bedrohungen – Technologische Urteilsfähigkeit und nukleare Sicherheit in Deutschland, Fraunhofer INT, Euskirchen

October 12 – 16, 2015
Exibition booth: International Astronautical Congress, Jerusalem, Israel

November 10, 2015
Closing Conference of the project EvoCS: BAO, Brussels

November 17 – 19, 2015
Exibition booth: Space Tech Expo Europe, Bremen

APPENDIX

Press Releases

Fraunhofer INT PI Workshop Industrie 4.0, 02/04/2015:
http://www.int.fraunhofer.de/content/dam/int/de/documents/Pressemeldungen/Fraunhofer%20INT%20PI%20Workshop%20Industrie%204-0.pdf

DRIVER Workshop für Krisenmanagement-Experten am 8. und 9. Dezember in Berlin, 11/27/2015:
http://www.int.fraunhofer.de/content/dam/int/de/documents/Pressemeldungen/Fraunhofer%20INT%20PI%20DRIVER%20Krisenmanagement%2027-11-15.pdf

DRIVER gibt finales Programm des I4CM Workshops in Berlin bekannt, 12/07/2015:
http://www.int.fraunhofer.de/content/dam/int/de/documents/Pressemeldungen/Fraunhofer%20INT%20PI%20DRIVER%20Krisenmanagement%207-12-15.pdf

I4CM Workshop erfolgreich beendet – Austausch zwischen Forschern und Praktikern wird intensiviert, 12/11/2015:
http://www.int.fraunhofer.de/content/dam/int/de/documents/Pressemeldungen/Fraunhofer%20INT%20PI%20DRIVER%20Krisenmanagement%209-12-15.pdf

Institute Course

Baum, M. (Fraunhofer INT):
Kurze Einführung in Multiferroika, Euskirchen 01/14/2015

Kerber, M. C. (Technische Universität Berlin):
– Die institutionelle Ökonomie des Galileo-Projektes: Problemherausforderung und Entwicklungsperspektive der europäischen Navigationspolitik, – Die Technologiepolitik des Bundesverteidigungsministeriums, Euskirchen, 21/01/2015

Engelhard, M. (EA European Academy GmbH):
„Synthetische Biologie – ein Vergleich zur Gentechnik und neue Fragen der biologischen Sicherheit“, Euskirchen, 1/28/2015

Haak, H. (KNMI Koninklijk Nederlands Meteorologisch Instituut):
Foresight in the context of the climate problem, Euskirchen, 2/18/2015

Dauch, W. (Ministerium für Inneres und Kommunales des Landes Nordrhein-Westfalen):
Schutz kritischer Infrastrukturen, Euskirchen, 3/18/2015

Steffens, M. (Fraunhofer INT):
Hyperfeinwechselwirkung in halbleitenden Oxiden am Beispiel von Ga_2O_3, Euskirchen, 4/15/2015

Römer, S. (Fraunhofer INT):
Future Study 2014 – Wirkmittelanalyse mit der Methode Assessment Game, Euskirchen, 4/22/2015

Ahrweiler, P. (EA European Academy GmbH):
Innovationsnetzwerke und deren Simulation mittels agentenbasierter Modelle, Euskirchen, 4/29/2015

Wiemken, U. (Fraunhofer INT):
Die Entwicklung technischer Autonomie. Was können und was dürfen Automaten?, Euskirchen, 5/6/2015

Weiss-Blankenhorn, P. (Forschungszentrum Jülich, Institut für Kognitive Neurowissenschaften):
Illusion und Neglect: Sehen ist nicht Wahrnehmen, Euskirchen, 5/13/2015

Biederbick, W. (Robert-Koch-Institut):
Globale Biosicherheit, Euskirchen, 5/27/2015

Heidmann, F. (FH Potsdam):
„FutureViz. Webbasierte Visualisierung und Exploration von Bildern der Mensch-Technik Interaktion als Toolbox für Zukunftsforschung, Innovationsmanagement und Technikethik.“, Euskirchen, 6/10/2015

Schulte, A. J. (Fraunhofer INT):
WettA: Bewertung von Technologiethemen für die Fraunhofer ZV, Euskirchen, 6/17/2015

Euting, T. (Fraunhofer INT):
Aortendissektion – Dringlicher Notfall in der Herzchirurgie, Euskirchen, 8/12/2015

Kammer, S. (DLR Raumfahrtmanagement):
Ariane – Eine Erfolgsgeschichte der Raumfahrt, Euskirchen, 8/19/2015

Rohrwild, K. (Hermann-Oberth-Raumfahrt-Museum Feucht):
Leitlinien der frühen Deutschen Raumfahrtgeschichte, Euskirchen, 2/9/2015

Grüne, M. (Fraunhofer INT):
Zur Wissenschaftlichkeit der Zukunftsforschung in der Abteilung TASP, Euskirchen, 9/30/2015

Roths, J. (Hochschule München):
Dehnungs- und Temperaturmessung mittels Faser-Bragg-Gitter-Sensorik, Euskirchen, 10/21/2015

Heidingsfelder,M. (Fraunhofer CeRRI):
Gender & Innovation, Euskirchen, 10/28/2015

Köhler, J. (Fraunhofer IAIS):
Content Analytics und Big Data: Methoden und Anwendungen, Euskirchen, 11/04/2015

Steffens, M. (Fraunhofer INT):
Abschirmung von elektronischen Bauteilen gegen ionisierende Strahlung im Weltraum: Auf der Suche nach leichteren und effizienteren Materialien, Euskirchen, 11/18/2015

Schumann, O. (Fraunhofer INT):
Analyse der IAEA-Berichte zum iranischen Atomprogramm, Euskirchen, 11/25/2015

Floeting, H. (Deutsches Institut für Urbanistik):
Urbane Sicherheit, Euskirchen, 2/12/2015

Lieberz, D. (Fraunhofer INT):
Perception of security in Europe, Euskirchen, 12/09/2015

Kretschmer, T. (Fraunhofer INT):
Klimawandel – Fakten und Kontroversen, Euskirchen, 12/16/2015

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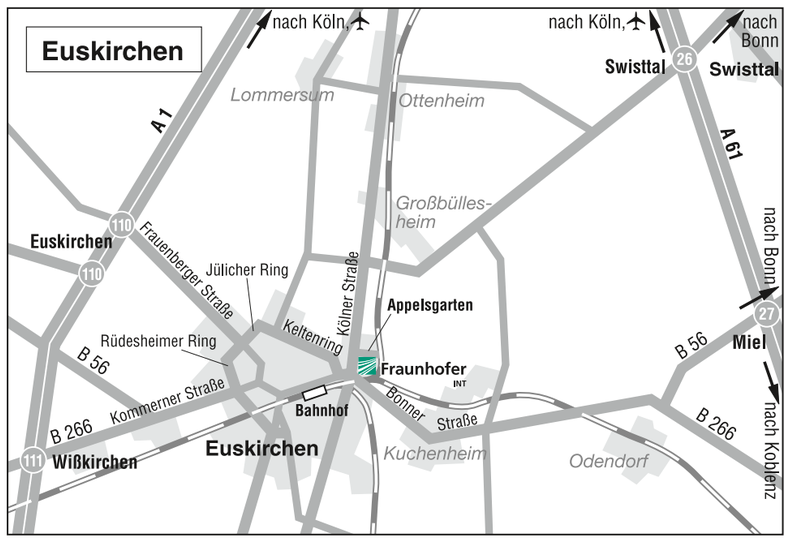

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