



Fraunhofer
INT

FRAUNHOFER INSTITUTE FOR TECHNOLOGICAL TREND ANALYSIS INT



ANNUAL REPORT
2019

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FOREWORD

»These are the stories that the Dogs tell when the fires burn high and the wind is from the north. Then each family circle gathers at the hearthstone and the pups sit silently and listen«.

This quotation from the preface to Clifford D. Simak's science fiction story »City« leads us to a distant future where humankind is no more and the most intelligent beings on earth are animals. It makes the point that some stories can exist, regardless of whoever tells them or acts in them.

In my schooldays, I was fascinated by the sagas of the ancient heroes. They told of long-lost worlds, of people who have been dead for thousands of years. Such stories bring these worlds to life in our imagination, and the heroes of the Iliad and Odyssey are immortal. Later, science fiction cast a spell over me, creating worlds in my mind that would only exist in the distant future, in remote places. There was often talk of technologies that – much in the meaning of Clarke's Third Law – bordered more on magic.

In contrast to the stories from the distant past, science fiction gives us only a few »immortal« heroes (one of which could be the HAL 9000 computer in Clarke's »2001: A Space Odyssey«), because in the meantime, some utopian concepts get overtaken by reality. Even ten years ago, who would have thought that humans could shape their own evolution, simply and cheaply? And 20 years ago, who would have spoken seriously about the technical realization of a symbiosis of artificial and natural intelligences?

When, in the course of my professional career, I concerned myself with technology foresight, I again ended up with stories from the future. After all, scientific reports are in essence stories that deal with questions on nature, methods for answering them, and the corresponding answers themselves. In the case of future research, they tell of possible developments and their consequences for our future life.

The narrator of such stories is however faced with a twofold problem: how much fantasy can these stories hold without being dismissed as fairy tales; how much must they contain to not be overtaken by reality in the shortest time? There is no all-purpose answer, since the listener plays such a decisive role with his power of imagination. Unlike the classic heroic sagas, the stories have to be tailored individually – handcrafted, so to speak.

The second problem is much more fundamental: our images of possible futures are colored by our current norms and ideas. Yet looking back into the past, we see how much these assessments can change – even over a short period of time. One thing is certain: the people of 2050 will see many things very differently from our view today, and their world will look very different from what we imagine today.

And perhaps they will have a slightly more optimistic worldview than ours. We seem to prefer darker forecasts: »Things used to be better« in »the good old days«. But there is another view of things, namely, the untold success story of humankind.

This is where you might well say that nobody wants to live like the heroes from the Bronze Age, and that there has definitely been some progress. But in the past 100 years, the modern world with all its technologies has become significantly worse and more unjust. Really?



If we look at the facts, the situation is very different:

At the onset of the 19th century, approx. 85 % of all people lived in extreme poverty (measured against purchasing power today, per capita income was less than \$2 a day). It is currently less than 9 %; the proportion of people living in extreme poverty has almost halved in the last 20 years alone. Most of humanity lives on a middle-income level and is thus able to eat better, buy consumer goods and provide education for their children.

Over the same period, child mortality (death below the age of five years) as a key indicator of health care quality and hygienic living conditions fell globally from more than 44 % to below 4 %, an almost incredible triumph of medicine and hygiene. Many more positive examples can be cited.

None of this was thanks to magic; the main contributors to this development were education, science and technology. But the fact that so much is getting better in no way means that everything is fine; there is still much to do. That is why we will continue to help with the writing of mankind's ongoing success story.

So join us in looking optimistically into the future, and read man-made stories about some positive developments that have involved the successful participation of Fraunhofer INT.

We wish you some good reading and inspiration.

Your

A handwritten signature in blue ink that reads "Michael Lauster". The signature is written in a cursive, flowing style.

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

PUBLIC TECHNOLOGY AND
INNOVATION PLANNING

BUSINESS UNIT

CORPORATE TECHNOLOGY
FORESIGHT

BUSINESS UNIT

NUCLEAR SECURITY POLICY
AND DETECTION TECHNIQUES

BUSINESS UNIT

ELECTROMAGNETIC EFFECTS
AND THREATS

BUSINESS UNIT

NUCLEAR EFFECTS IN ELECTRONICS
AND OPTICS

ORGANIGRAM

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FRAUNHOFER INT FACTS AND FIGURES

Staff

In 2019, we adjusted staff numbers at Fraunhofer INT to reflect the well-filled order book, especially regarding the number of scientists. At the end of the year, we employed 123 people with 108.1 full-time equivalents, including 65 scientists (60.2 full-time equivalents). With this staff we cover a wide range of natural and engineering sciences, together with economics, humanities and social sciences. The scientists are supported by graduate engineers, technicians and administrative staff.

More support comes from student and scientific assistants, as well as trainees. INT also has access to a network of freelance scientists who regularly work together with the Institute.

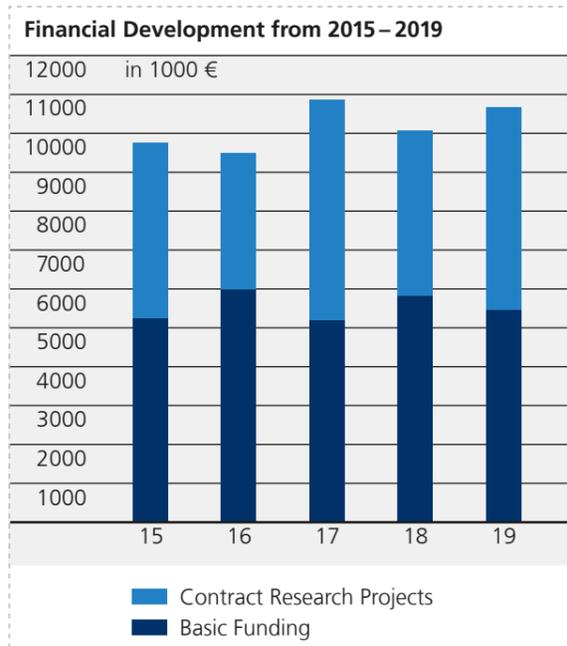
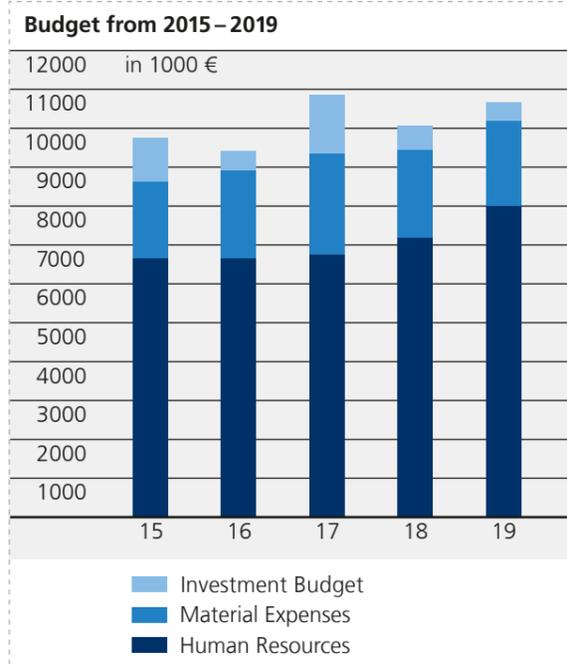
Budget

The Fraunhofer-Gesellschaft distinguishes between operating and investment budgets. The operating budget covers all staffing and administrative expenditure, while the investment budget concerns the procurement of capital goods such as scientific apparatus and technical equipment. The operating budget rose to € 10.2 million in 2019. Together with investments totaling € 472,000, the total budget amounted to € 10.7 million.

Almost completed is construction work on an experiment hall, an investment of approx. € 1.5 million. This is another significant expansion of the Institute's experiment capacity.

Along with basic funding from the Federal Ministry of Defence (BMVg), which enables the implementation of a coordinated research program, INT also receives basic funding from Federal and state 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. Project



Personal	2017		2018		2019	
	Manned positions	People	Manned positions	People	Manned positions	People
Scientists	56.3	60	55.5	59	60.2	65
Graduates	24.0	24	24.0	25	24.0	25
Technicians, Others	14.0	17	16.0	18	17.1	19
Assistants, Trainees	6.6	15	3.9	7	6.8	14
Total	100.9	116	99.4	109	108.1	123

clients come from the public sector, SMS companies and DAX-30 groups in various industry fields, and they also include associations and international organizations.

come comes from EU projects which are jointly conducted with partners from many European nations.

In the public sector, Fraunhofer INT has for 40 years provided BMVg, the largest client for INT in Euskirchen, with in-depth consultancy expertise in research and technology planning. In addition, research assignments are also carried out for other ministries and public institutions. A considerable share of in-

Budget	in 1.000 €	2015	2016	2017	2018	2019
Expenses						
Operating Budget		8643.4	8914.7	9312.3	9509.3	10211.2
of which Human Resources		6660.5	6760.7	6858.3	7231.5	7996.8
of which Material Expenses		1982.9	2154.0	2454.0	2277.8	2214.4
Investment Budget		1116.2	549.4	1515.5	561.9	472.7
Total		9759.6	9496.1	10826.8	10071.2	10683.9
Funding						
Basic Funding		5233.6	6004.9	5152.0	5862.3	5475.5
Contract Research Projects		4526.0	3459.2	5674.8	4208.9	5208.4

ADVISORY BOARD



The institute is given advice by an advisory board which is composed of personalities from industry, science, politics and administration.

Chairman

Prof. Dr. Horst Geschka; Geschka & Partner Unternehmensberatung Innovarium

Members

- Herr Udo Becker, Vorstand Kreissparkasse Euskirchen
- Herr Klaus Burmeister; foresightlab
- Herr Dr.-Ing. Karsten Deiseroth; IABG mbH
- Herr Prof. Dr. Horst Geschka; Geschka & Partner Unternehmensberatung Innovarium

- Frau Dr. Vera Kamp, Plath GmbH
- Herr Erster Direktor BAAINBw Dipl.-Ing. Rainer Krug; Bundesamt für Ausrüstung, Informationstechnik und Nutzung der Bundeswehr
- Frau Britta Schade, ESA / ESTEC
- Herr Dir. Prof. Dr. Winfried Schuhn; Wehrwissenschaftliches Institut für Schutztechnologien – ABC-Schutz
- Frau Prof. Dr. Katharina Seuser, Hochschule Bonn-Rhein-Sieg
- Frau Sabine ten Hagen-Knauer; Bundesministerium für Bildung und Forschung
- Herr MinR. Dipl.-Ing. Norbert Michael Weber; Bundesministerium der Verteidigung
- Herr Dr.-Ing. Thomas Weise; Rheinmetall AG
- Herr Dr. rer. pol. Hans-Ulrich Wiese; ehemals Fraunhofer-Vorstand
- Herr Prof. Dr. Dr. Axel Zweck; VDI Technologiezentrum

1 Advisory Board Meeting on June 5, 2019

THE FRAUNHOFER-GESELLSCHAFT

The Fraunhofer-Gesellschaft is the world's leading applied research organization. With its focus on developing key technologies that are vital for the future and enabling the commercial exploitation of this work by business and industry, Fraunhofer plays a central role in the innovation process. Based in Germany, Fraunhofer is an innovator and catalyst for groundbreaking developments and a model of scientific excellence. By generating inspirational ideas and spearheading sustainable scientific and technological solutions, Fraunhofer provides science and industry with a vital base and helps shape society now and in the future.

At the Fraunhofer-Gesellschaft, interdisciplinary research teams work together with partners from industry and government in order to transform novel ideas into innovative technologies, to coordinate and realize key research projects with a systematic relevance, and to strengthen the German and the European economy with a commitment to creating value that is based on human values. International collaboration with outstanding research partners and companies from around the world brings Fraunhofer into direct contact with the key regions that drive scientific progress and economic development.

Founded in 1949, the Fraunhofer-Gesellschaft currently operates 74 institutes and research institutions. The majority of our 28,000 staff are qualified scientists and engineers, who work with an annual research budget of 2.8 billion euros. Of this sum, 2.3 billion euros is generated through contract research. Around 70 percent of Fraunhofer's contract research revenue is derived from contracts with industry and publicly funded research projects. The remaining 30 percent comes from the German federal and state governments in the form of base funding. This enables the institutes to work on solutions to problems that are likely to become crucial for industry and society within the not-too-distant future.

Applied research also has a knock-on effect that is felt way beyond the direct benefits experienced by the customer: our institutes boost industry's performance and efficiency, promote

the acceptance of new technologies within society, and help train the future generation of scientists and engineers the economy so urgently requires.

Our highly motivated staff, working at the cutting edge of research, are the key factor in our success as a scientific organization. Fraunhofer offers researchers the opportunity for independent, creative and, at the same time, targeted work. We therefore provide our employees with the chance to develop the professional and personal skills that will enable them to take up positions of responsibility at Fraunhofer, at universities, in industry and within society. Students who work on projects at Fraunhofer Institutes have excellent career prospects in industry by virtue of the practical training they enjoy and the early experience they acquire of dealing with contract partners.

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

Caroline Schweitzer



We carry out research into the security of mankind, society and the state – for a life of freedom

In times of social and political unrest, defence and security become increasingly important. We develop technologies, products and services for the early detection of dangerous situations, so that they can be counteracted, consequential damage can be minimised and, as a result, the overall level of risk can be reduced.

The Fraunhofer Group for Defence and Security pursues research and development in the areas of defence and civil security. Our wide-ranging expertise and research have delivered highly practicable solutions and operational support, both at the national and international level. In defence research, our excellent judgement and consultancy skills make us indispensable independent experts and partners of the German Ministry of Defence (BMVg). We research and develop technologies and system solutions for the Ministry, its government bodies and for the German Armed Forces (Bundeswehr). Our technical solutions and systems in civil security are designed to deliver the best possible protection for society.

We cover the interests and activities of our member institutes, acting as their representative both within and outside the organisation. We create joint benefits through mutual support, by complementing one another professionally, through a division of labour and by coordinating the areas in which we specialise.

Areas of application

The Fraunhofer Group for Defence and Security provides comprehensive security models: Our research focuses on security and protection against military, technical, terrorist, natural and criminal threats. From this, we deduce the areas of application for our research:

- Systems and technologies for use on land, in the air, water, space and cyberspace

- Information gathering, provision of information and decision-making support
- Networked operations
- Protection and impact
- Electronic warfare
- Cross-system technologies
- Resilience and protection of critical infrastructures
- Combating of terrorism and crime
- Border security
- Crisis and disaster management
- Digital transformation

Our distinctive features

- Coordination of large-scale projects
- System solutions to complex issues
- Excellent infrastructure and laboratory equipment
- Continuous availability of technical expertise
- Superb network with research, industry and government
- Thorough judgement and consultancy skills in defence research and technology
- Interdisciplinary work and broad technology Portfolio

Range of services

- Feasibility studies
- Strategic forecasting, scenarios and roadmapping
- Technological needs and trend analyses
- Development of methods, technologies, components and systems
- Assessment of (third-party) systems
- Development of prototypes and processes
- Pilot series production

Contact Person

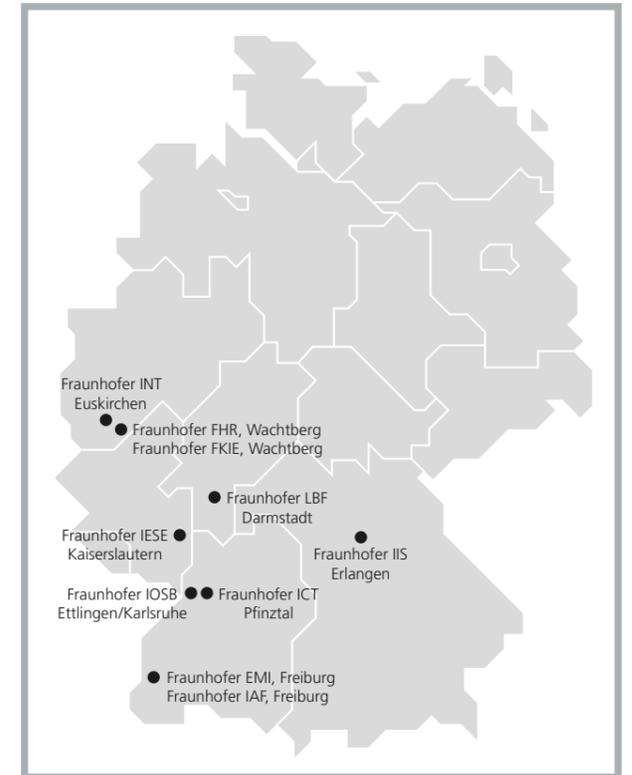
- Group Chairman Prof. Dr.-Ing. Jürgen Beyerer, Fraunhofer IOSB
- Group Deputy
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Members

- Fraunhofer Institutes for High-Speed Dynamics, Ernst-Mach-Institut, EMI; Protection, Security and Effects
- Fraunhofer Institutes for High Frequency Physics and Radar Techniques FHR; Radar – A Key Technology
- Fraunhofer Institutes for Communication, Information Processing and Ergonomics FKIE; Command, Control and Reconnaissance
- Fraunhofer Institute for Applied Solid State Physics IAF; Sensors for Safety, Security and Reconnaissance
- Fraunhofer Institute for Chemical Technology ICT; Security, Safety and Energetic Materials Technology
- Fraunhofer Institute for Technological Trend Analysis INT; Planning Support for State and Industry
- Fraunhofer Institute of Optronics, System Technologies and Image Exploitation IOSB; From Networked Sensor Data to Decision

Associated members

- Fraunhofer Institute for Experimental Software Engineering IESE; Software and Systems Engineering
- Fraunhofer Institute for Integrated Circuits IIS; Communication, Positioning Technologies and X-Ray for Safety and Security Applications
- Fraunhofer Institute for Structural Durability and Systems Reliability LBF; Secure Processes for secure Structures



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

FRAUNHOFER GROUP FOR INNOVATION RESEARCH

Juliane Segede, Dr. Sven Schimpf

Which topics will shape applied research in the future?

To meet the challenges facing current and future innovation systems, not only existing approaches to innovation research have to be mastered, but new, cross-discipline paths also need to be followed. The Fraunhofer Group for Innovation Research brings together all the relevant instruments, methods and measures available at the participating institutes: Fraunhofer IAO, IMW, INT, IRB and ISI, as well as at the guest institutes Fraunhofer IIS and IMWS. The Fraunhofer institutes within the group thus cover a broad spectrum of skills and methods in socio-technical and socio-economical research.

In 2019, the Fraunhofer Group for Innovation Research offered the industry a wide range of orientation aids and support services in the form of initiatives, projects, events and publications.

Contact Person

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 Managing Director Dr. Sven Schimpf, Fraunhofer IAO
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Participating Institutes

- Fraunhofer Institute for Industrial Engineering IAO
- Fraunhofer Institute for Technological Trend Analysis INT
- Fraunhofer Information Center for Planning and Construction IRB
- Fraunhofer Center for International Management and Knowledge Economy IMW

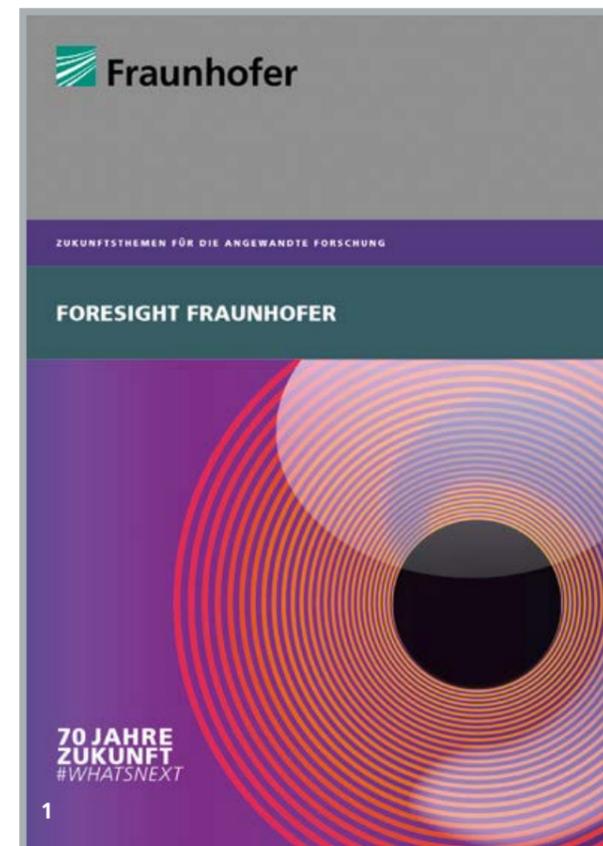
Guest Participants

- Fraunhofer Institute for Integrated Circuits IIS

Three highlights deserve special mention:

The Publication »Foresight Fraunhofer« spotlights 51 technological topics

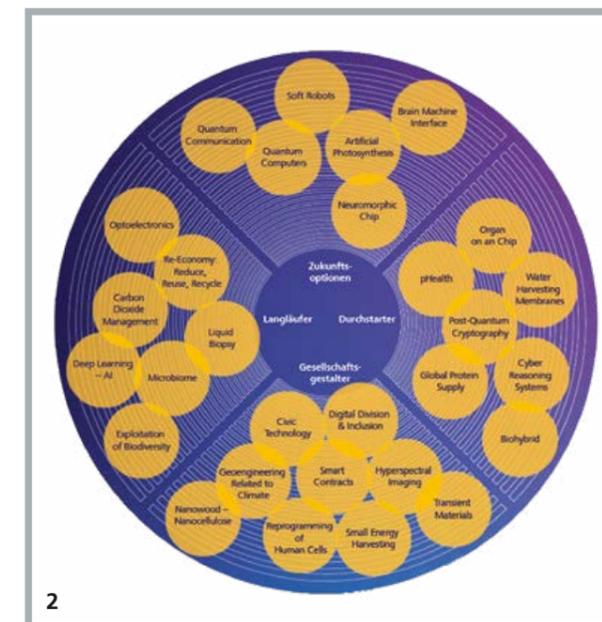
Acting for the Fraunhofer-Gesellschaft, the Fraunhofer Institute IAO joined forces with other innovation research group institutes to identify the future's key topics for applied research. A foresight process was used to analyze technological and social developments with regard to their innovation potential and relevance for research fields and branches of industry. Several topics in the limelight, such as geo-engineering, came in for particularly controversial discussion. The study is freely available at: <http://s.fhg.de/foresight-fraunhofer>



1

15th Symposium for Foresight and Technology Planning

Together with acatech and Paderborn University's Heinz Nixdorf Institute, the Fraunhofer Group for Innovation Research staged the 15th Symposium for Foresight and Technology Planning, held November 21/22. The event focused on methods and tools for future-oriented corporate design, innovative applications and field reports, as well as on the dialog between science and business. The Fraunhofer Group contributed to the program with practical talks from innovation research, such as in mobility-in-disruption, marketing frugal innovations, or the analysis of organization-specific biases in the context of innovation management and foresight. The 16th event is scheduled for November 19/20, 2020, in Berlin.



2

The »Innovate like« Card Game

The innovation card game »Innovate like ...« is a playful tool that helps to take on different perspectives and widen the horizons of your own ideas.



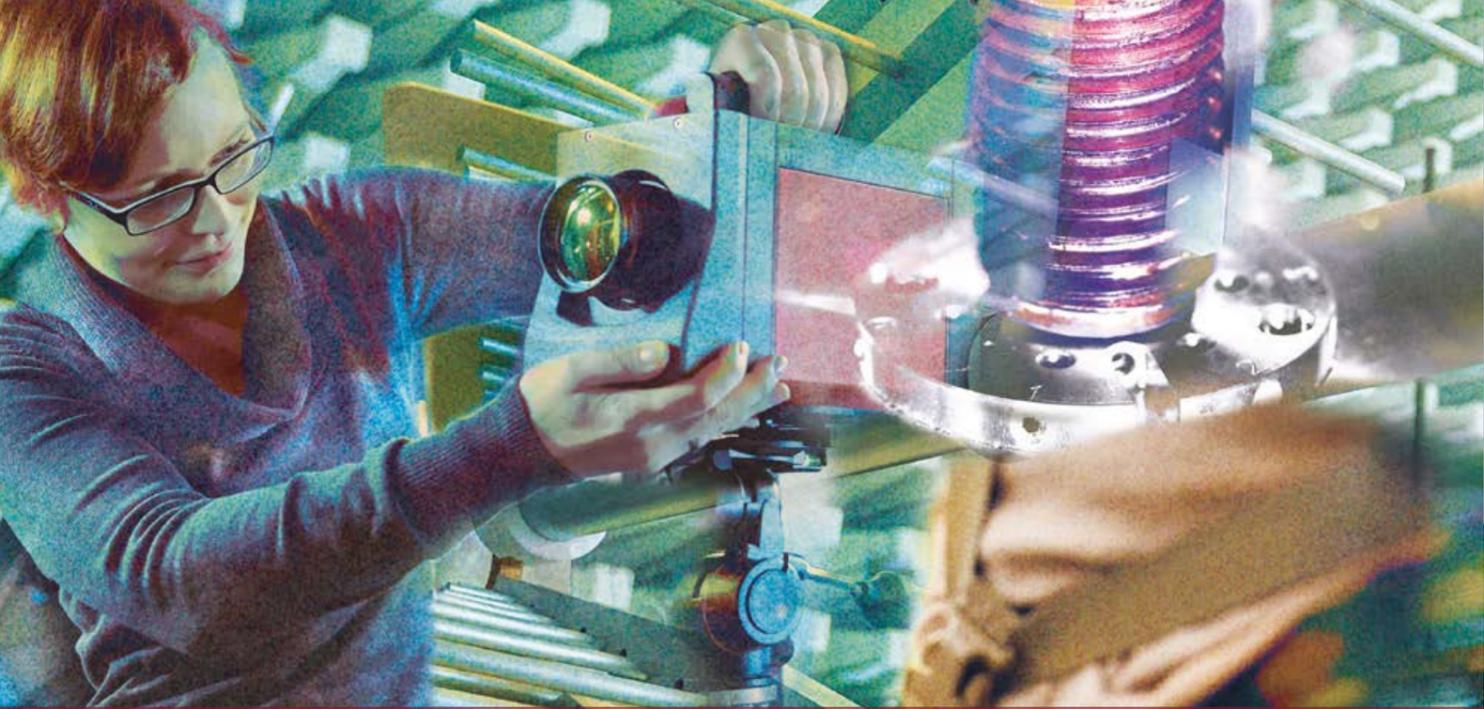
3

The 31 cards provide a selection of innovation icons, each with a quotation and a list of four key characteristics. The cards are the cue for looking at your own challenges from a different perspective.

1 Publication »Foresight Fraunhofer«

2 Overview of the 30 special topics of future relevance

3 Card Game »Innovate like«



BUSINESS UNIT »DEFENSE TECHNOLOGY FORESIGHT – WZA«

Hans-Martin Pastuszka

The Business Unit »Defense Technology Foresight (WZA)« conducts long term, technology-oriented futures research (**technology foresight**) for public sector clients in the field of defense. The unit's institutional mission is to act as **technology radar for the Federal Ministry of Defence (BMVg) and the Bundeswehr**, and to provide evidence-based, technology-oriented decision support for the clients' strategic planning processes. For BMVg and the Bundeswehr, WZA is also an important information broker on findings from technology-oriented foresight, and ensures a continuous transfer of corresponding knowledge. It also serves international clients, such as the European Defence Agency and NATO.

The technology oriented futures research of WZA provides its clients with reliable knowledge for their orientation, and decision-making guidance on likely future developments in science and technology and their potential military implications. In particular, this includes the early detection of emerging technologies and their assessment with regard to their risks and opportunities for defense. WZA thus helps to gain insights into global long-term technological developments, ensuring a broad analysis and assessment capability for clients in defense research and technology.

WZA's core product remains the **»Defense Technologies Forecast (Wehrtechnische Vorausschau, WTV)«**, which is

compiled quarterly for BMVg and the Bundeswehr. As in the years before, this was also the main focus of work for the Business Unit in 2019. In all, 13 analyses and updates on selected technology themes and long-term system and capability concepts were produced. Jointly with the client, WZA ran two workshops on the results and recommendations. The circle of WTV's civilian users remained strong. The Federal Criminal Police Office (Bundeskriminalamt, BKA), the Federal Office of Civil Protection and Disaster Assistance (Bundesamt für Bevölkerungsschutz und Katastrophenhilfe, BBK), the Bundeswehr's central non-military IT service provider (Bundesgesellschaft BWI GmbH) and the Federal Office for Materials Research and Testing (Bundesanstalt für Materialforschung- und Prüfung) all receive

a special WTV edition. Likewise, the WTV goes to the Royal Netherlands Army in line with a bilateral agreement with BMVg.

As the client's long-term technology foresight paper, WTV was again a major topic source for the annual R&T Forecast for the Director of R&T in BMVg. This forecast had been produced for the first time in the previous year, with comprehensive WZA contributions on content and organization. BMVg's intention here is to cover all currently recognized long-term, technology driven future topics in the various organizational areas of BMVg and the Bundeswehr, and condense them in the R&T Forecast. This includes BMVg-funded research institutes in the Fraunhofer Group for Defense and Security (FraunhoferVerbund für Verteidigungs- und Sicherheitsforschung, VVS), the German Aerospace Center (Deutsches Zentrum für Luftund Raumfahrt, DLR) and the French-German Research Institute of Saint-Louis (Deutsch-Französisches Forschungsinstitut Saint-Louis, ISL). The 2nd R&T Future Situation Conference was held at Fraunhofer INT on February 19/20, on behalf of and chaired by the Director of R&T in BMVg, with just under 60 participants.

Also in the past year, brief technology analyses were conducted on selected topics in line with the continued mandate from the Swedish Defence Administration (FMV). Following the EDA Framework Agreement »Technology Foresight Follow-On« (17.ESI.OP.373) with the Spanish contractor Isdefe – up and running since the end of 2017 – WZA staff joined in the staging of a foresight workshop in May 2019 on »Quantum Technologies for Defence«.

The WZA team acted as anchors and technology experts. Cross-field contributions by WZA included special work on the Fraunhofer Society's internal research project FRAME (Fraunhofer Microelectronics Innovation Enhancement) for the Research Fab Microelectronics Germany (Forschungsfabrik Mikroelektronik Deutschland, FMD). Work here was conducted on the module »Foresight and Roadmaps«.

WZA's teaching and committee work includes in particular technical support for the Bundeswehr Staff College (Führungsakademie der Bundeswehr). For the sixth successive year, WZA contributed to the module »Methods of Analyzing the Future«, with talks on both WZA and WTV, as well as on the method of the »Disruptive Technology Assessment Game«. In addition, there was demand for similar talks in the »Strategic Planning«

module, and in the General and Admiral Staff courses (LGAN 2018), where the half-day workshop »Technologies, Impetus, Themes« was held for the first time. These information transfers for the Bundeswehr were rounded off in 2019 by further talks and active participation in the future workshop »Trends and Innovations in Bundeswehr Logistics«, run by the Bundeswehr and the Cyber Innovation Hub (CIH), as well as the annual further training conference of the Bundeswehr's NBC Defense Command. Other teaching activities concerned the technical design of courses on »Methods of Future Analysis« at the universities of Bonn-Rhein-Sieg and Ravensburg-Weingarten. In addition, WZA continued its work in co-shaping NATO's »Science for Peace and Security« program through expert reviews for its »Independent Scientific Evaluation Group« (NATO-SPS-ISEG). More than 36 research applications and two intermediate project reports were assessed.



BUSINESS UNIT »TECHNOLOGY AND INNOVATION PLANNING FOR THE PUBLIC SECTOR – TIP«

Dr. Sonja Grigoleit

The Business Unit »Public Technology and Innovation Planning (TIP)«, supports strategic research and innovation planning for public sector clients such as the European institutions and authorities, as well as for national public bodies. Services range from the development of research agendas at national and European level, to drawing-up strategic plans for capability development in public bodies and authorities.

Thematically, the Business Unit's main focus is on technology and innovation planning in the field of civil security. However, areas outside security research are now playing an ever increasing role.

TIP offers its clients and contractors a wide range of methods for innovation and technology management:

- Needs and User Experience (UX) analysis using participatory methods
- Screening of possible (future) technological and non-technological solutions
- Analysis of organizational, social and political factors
- Developing research roadmaps for policy-makers
- Writing innovation roadmaps for users

- Developing critical success factors and key performance indicators for evaluating new technologies in pilots and demonstrations
- Further developing and adapting knowledge transfer methods in order to set up cooperation structures and networks

The main task for TIP is **security research**. Together with its partner organizations, TIP develops innovative solutions in cross-border crisis management and resilience research, and designs innovation planning concepts.

In the EU project IN-PREP (duration 2017–2020), TIP is responsible for assessing user requirements, evaluating tests and demonstrations for the platform under development, as well as for writing a handbook on cross-border cooperation in crisis situations.



For the Fire & Rescue Innovation Network **FIRE-IN**, an EU project running from 2017 to 2022, TIP is supporting mutual needs analysis and innovation planning methods for an international network of fire services and other first responders.

The EU project **SmartResilience**, launched in 2016 dealt with the resilience of critical infrastructures in smart cities and was successfully completed on schedule in 2019. One of TIP's tasks was to analyse existing approaches for measuring resilience and challenges in smart technologies and infrastructures.

For the European Directorate General for European Civil Protection and Humanitarian Aid Operations **DG ECHO**, TIP is collaborating with the consultancy firm Ecorys to implement a **Peer Review Procedure** (duration 2018–2020) for civil protection systems in six states that have signed up to the EU civil protection mechanism. The three states for 2019 were Serbia, Portugal and Algeria. In another DG ECHO project, TIP and Ecorys are working on a forest fire fighting concept for **European Hubs in Disaster Protection and Management**, running from 2019 to 2020. The aim is to achieve the optimum use of existing knowledge and experience in European disaster risk management.

Nationally, TIP continued its successful association with the **Federal Agency for Technical Relief (Technisches Hilfswerk, THW)** with the signing of a bilateral cooperation agreement at institute level. The intention is providing long-term, strategic support for research and innovation planning for THW.

Beyond the realm of security research several other projects have been processed, amongst which the Federal Ministry of Education and Research project **WIDENING HORIZONS – CHANGING PROSPECTS** (running 2017–2020) deserves special mention. Concerned with developing promotion strategies for transferring scientific research results to rural areas, TIP is cooperating with the business unit CTF to generate new participative methods for technology foresight and for identifying tailor-made technology solutions for the rural landscape.

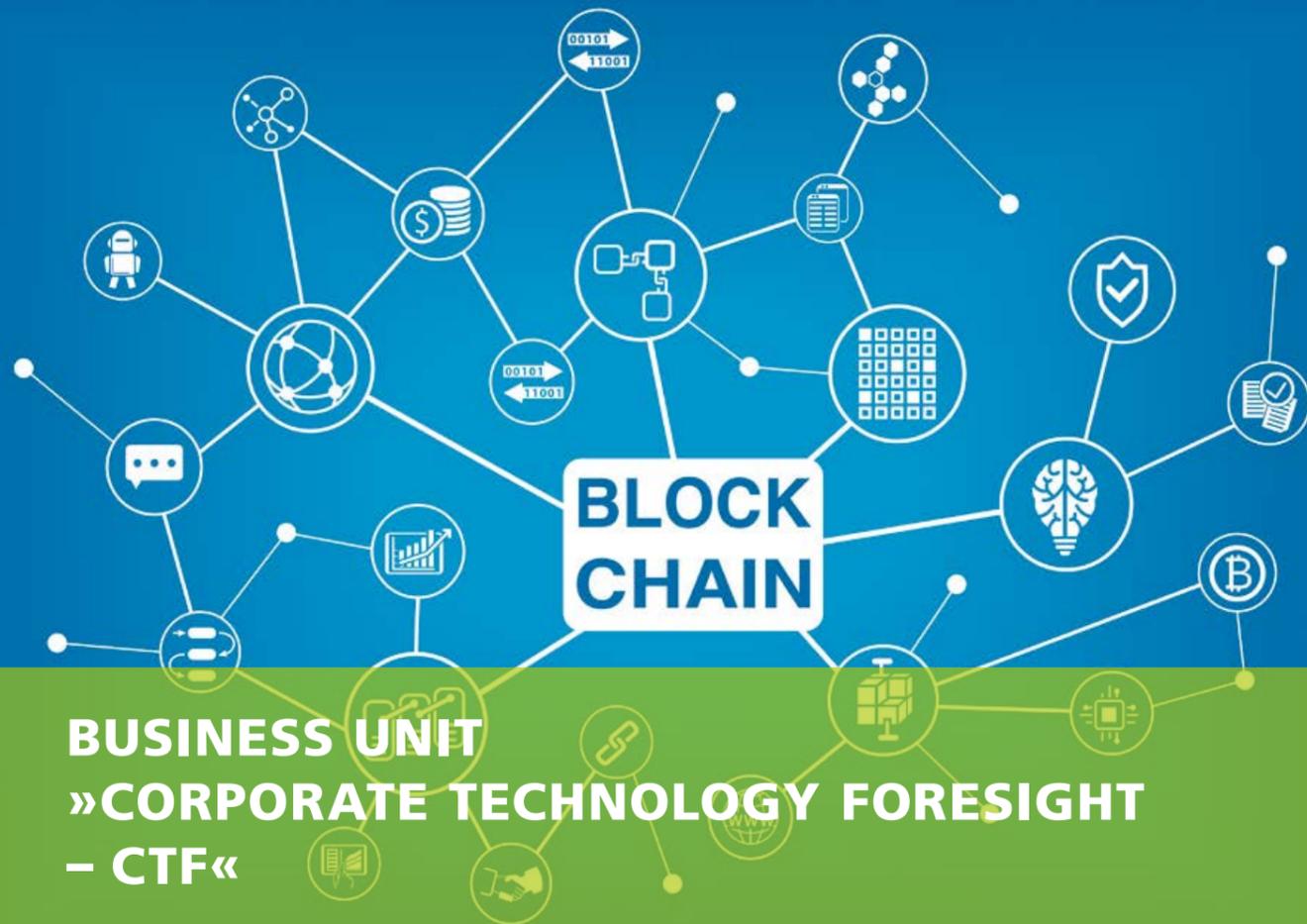
Also, at national level, 2019 saw the start of North Rhine-Westphalia's **Blockchain Reallabor** project (2019–2020), where a blockchain real-world laboratory will be brought to life. Together with CTF and other partners, TIP is helping to set up this laboratory for blockchain applications in the Rhineland coalfield. TIP's tasks are the INT-internal project leadership, requirement analysis and stocktaking, identifying implementation conditions, and the adaptation and development of participative methods for integrating various stakeholders.

On EU-level, the innovation project **SHAPES** was launched, which runs until 2023. With a budget of € 18.7 million and 36 partner organizations, this project is concerned with developing digital solutions for supporting and extending healthy and independent living for older individuals. One of TIP's tasks in the project is the leading of a work package that plans and evaluates pilot activities in the 15 pilot locations.

Closely related to these activities, TIP in addition addresses societal questions regarding security and new technologies.

The Business Unit also provides an expert for the **NATO Science for Peace and Security Programme**, and represents the Fraunhofer Group for Defense and Security (VVS) at the **Working Group Security and Defense Research** of the **European Association for Research and Technology Organisations (EARTO)**. In addition, TIP participates in the Fraunhofer Group for Innovation Research, the German Innovation Cluster for Security Research (InCluSif), the innovation network »LAND: LIFE: FUTURE«, and acts as advisor for larger research projects.

¹ Disaster control exercise for the IN-PREP project on floods in Kampen, Netherlands



BUSINESS UNIT »CORPORATE TECHNOLOGY FORESIGHT – CTF«

Dr. Anna Schulte

Strategic foresight procedures that assume clear future predictions are no longer enough to make technology intensive organizations resilient to an uncertain future. Relationships between widely varying technological, social, economic or political spheres are just too complex. At the same time, the information flood is increasing in both scientific landscape and the media. Against this background, robust preparation for the future calls for a systematic, scientifically-founded analysis of these different fields of influence, combined with the comprehensive, structured capture and analysis of the technical information concerned.

The Business Unit Corporate Technology Foresight (CTF) supports organizations in their search for answers to strategic questions. The focus is on technology-oriented research into innovation and future developments. CTF looks back on many years of experience in technology foresight and strategic planning. To take account of a wider range of relevant aspects, for example in business or society, CTF cooperates with top-range partners. With the backing of customer-specific analyses and methods for technology-oriented research into the future, the short-range perspective of 3 to 5 years often already found in companies is extended by a long-range perspective of 5 to 20 years. These analyses can show up and assess future technologies relevant to a company, highlight technological white spots, or break down complex technology areas and their implications for an enterprise. This information can lay the

scientific foundation for developing long term technology strategies.

Projects

Blockchain Reallabor in the Rhineland Coalfield

Especially focusing on industries located in the Rhenish (lignite) mining district in North Rhine-Westphalia, namely energy, production, logistics, finance and insurance, as well as services that support them, the project aims at developing practical use cases to demonstrate the potential of blockchain technology. These applications are intended to serve as the basis for creating a living lab in the Rhenish (lignite) mining region and beyond. The project will involve players in and outside the region, from

science, existing businesses and start-ups, as well as associations from all over North Rhine-Westphalia. The aim is to identify necessary research themes and to test the most promising in the new real-world laboratory.

On top of purely technological aspects, the project started with an inventory and requirement survey for Distributed Ledger Technology (DLT), with the focus on North Rhine-Westphalia. Among other things, likely players and application possibilities on the basis of current and future blockchain technology potential were identified. The Science Observatory at Fraunhofer INT made a major contribution to this. The Science Observatory at Fraunhofer INT contributed by establishing a continuous technology scouting and monitoring process supported by the assistant system KATI (Knowledge Analytics for Technology & Innovation) developed at Fraunhofer INT. Over and above this, creative methods for integrating stakeholders in innovation processes were adapted and developed at Fraunhofer INT.

Research Map Logistics

The Center of Excellence Logistics and IT is an amalgamation of several players at the science location Dortmund, where interdisciplinary groups called »Research Clans« are working on logistics-related research. To ensure that the focus remains on the »right« themes in the future – and thus to justify continued funding – the center worked together with Fraunhofer INT to develop a »research map«. The purpose was to map the field of logistics and to specify possible future research priorities.

This joint project was implemented in approximately three months. In the foreground for the first phase was the systematic recording of all the influence factors, trends and drivers affecting logistics, as well as the writing of a taxonomy that heads up all essential logistics topics. In phase two, large-group workshops evaluated the influence these trends have, making it possible to identify promising future topics with the use of a »heat map«. At the Center of Excellence the know-how acquired was subsequently compared with the future topics.

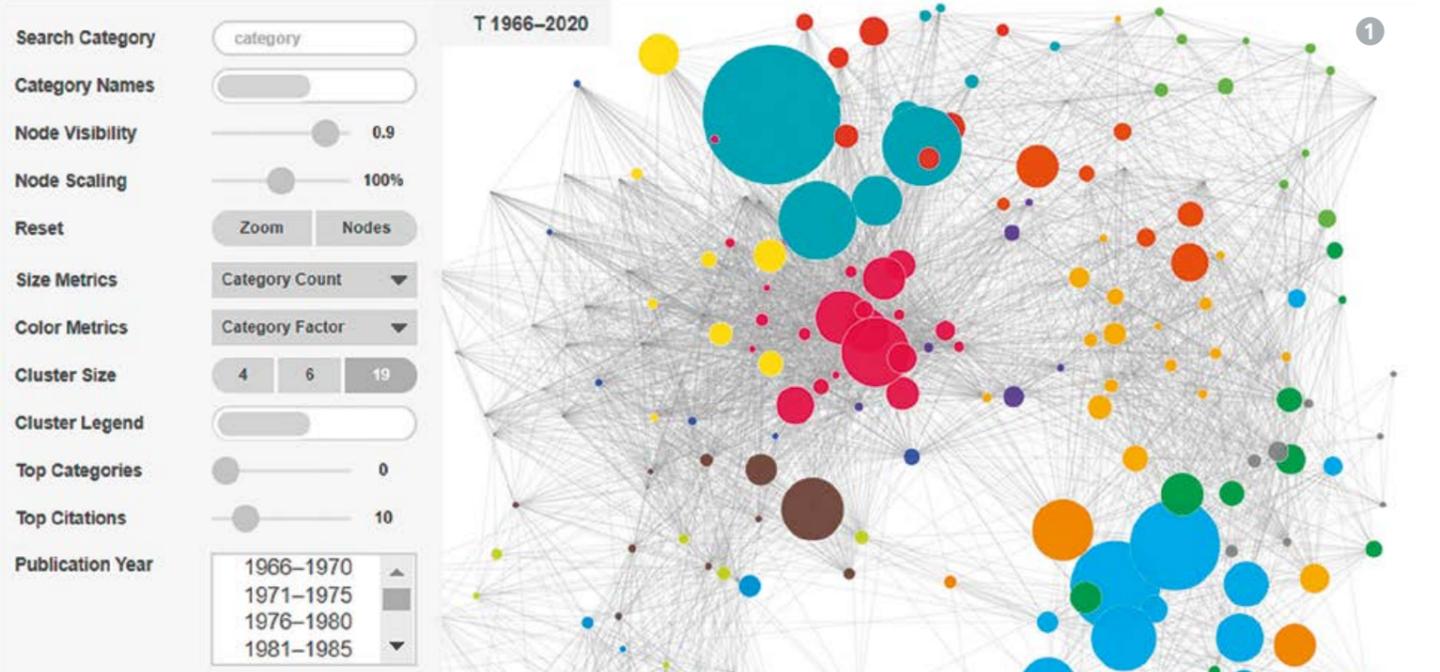
In the case of an emerging topic, the factors »relevance« and »know-how« on the resulting research map show whether a) there should be further observation, b) research gaps should be closed, or c) the existing state should be enhanced. This also reveals topics that are not considered relevant enough for further research.

Scenarios in Aviation / MRO 2040

The Maintenance, Repair and Overhaul market (MRO) in aviation is in a state of constant change. This manifests itself in the sustained growth in air traffic and high price pressure, combined with high technical complexity. Fraunhofer INT supported a leading MRO service provider in the identification of possible development channels by generating future scenarios for the sector up to the year 2040.

The scenario technique is a high-performance method for strategic foresight, especially renowned for prognoses over the long term. Future scenarios generated in the six-month project provide insights into the general environment (politics, economy, society), the aviation-specific environment (mobility, infrastructure, energy), and the specific design of the MRO services to be provided. For each outlined future scenario, opportunities and risks were considered, from which, in turn, new potentials and threats can arise for the company concerned.

A second work block listed up single technology topics that could become more interesting for MRO providers in the future. A subset filtered from the list was analyzed in depth with regard to technical development status and the main players. The results from the project are helping the company to pursue a more proactive line in innovation and technology management.



GROUP »TOOLS AND METHODS«

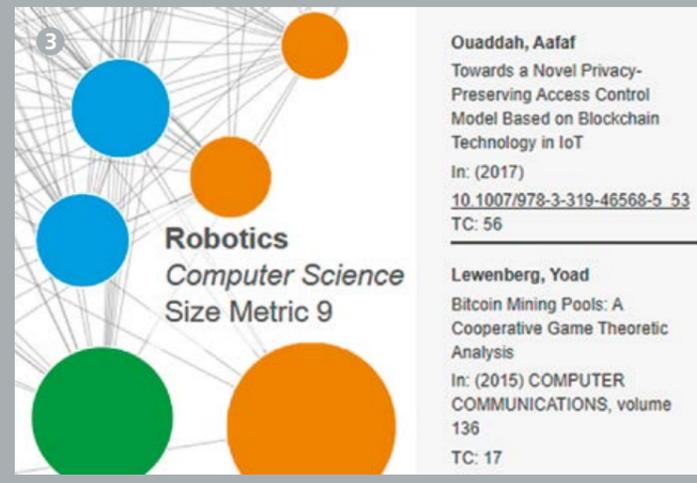
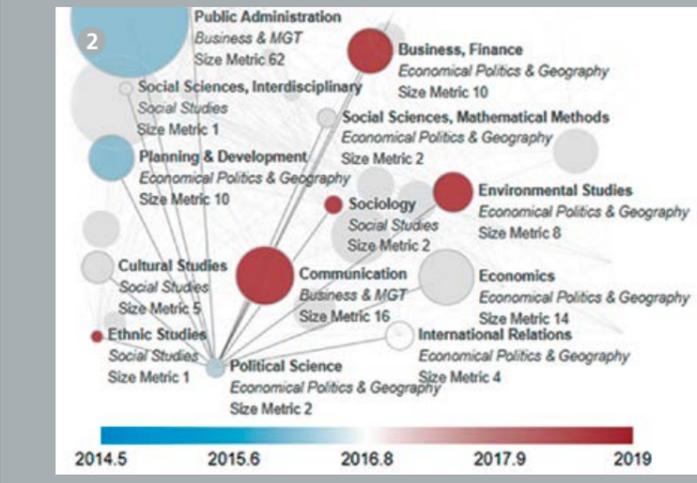
Dr. Miloš Jovanović

For the business units WZA, TIP and CTF, economic success and work quality depend on the tools and methods used. Named correspondingly, the group »Tools and Methods (TM)« has the task of supporting these business units. This includes in-house development of tools, and evaluation of appropriate methods (as, for example creative or workshop methods). An important aspect is that TM not only selects and provides tools, but also supports their introduction and application, e. g. with workshops. Work is not conducted in isolation in a metaphoric »ivory tower«, but takes place within the scope of the various business units' projects.

TM group members contribute not just methodologically, but also professionally, whenever appropriate and useful. This facilitates the identification of individual needs within the business units compared to drawing conclusions as an outside observer only. The group also promotes **collaboration with universities** in the field of methodology, so far largely through supervising university theses. The following illustrates some highlights that arose in the previous year within the TM Group and in cooperation with the business units. Also described are events with TM participation, and the long-term tasks which the group is responsible for.

Highlights and Events

- The project **Fraunhofer Microelectronics Innovation Enhancement (FRAME)** was continued in 2019. TM tasks included researching further microelectronics topics, drafting technology maps, and organizing and running project workshops. Further specification of future topics was achieved through cooperation with the Research Factory for Microelectronics Germany (Forschungsfabrik Mikroelektronik Deutschland, FMD).
- Several **country reports** were again written on behalf of WZA in 2019. The methodological focus was on source material collection and analysis.



- The project »**Foresight Fraunhofer**« was successfully completed in 2019. The results of the project's first phase – comprising various potential future topics identified for the Fraunhofer-Gesellschaft in a foresight process, as well as their analysis – were published in the first half of the year. In November, the **Fraunhofer Foresight Day** took place in Berlin. This was a platform for presenting project results and the methods used, as well as for discussion among those interested in foresight in the Fraunhofer-Gesellschaft. At the same time, the project work included research on new foresight methods, and the enhancement of the research and analytics tool **KATI – Knowledge Analytics for Technology & Innovation** (an in-house development by Fraunhofer INT, and a focal point for TM). The enhancement consisted of a visual representation of the research landscape (called »Overlay Maps«, see Figure 1), which can help in analyzing the topicality of various themes, and to identify more potential future topics that can serve as input for a foresight process.
- In the development of KATI, the focus was on implementing additional analysis options and visualizations (see for example the Foresight Fraunhofer project above), as well as on developing further data sources (e. g. patents). Furthermore, bugs were removed and user-friendliness underwent continuous improvement, taking into account the feedback of KATI users for the conceptual design of the system. A lot of attention was given to in-house workshops and other means of training colleagues with regard to the use of the tool. To facilitate cooperation with stakeholders from research and industry, meetings with other Fraunhofer institutes, ministries and small and mid-tier companies were held. KATI was also presented at the **Hanover Fair**, the **AI-enabled Technology Foresight Summit**, and the Fraunhofer conference **Futura in Res**.
- Several collaborations with universities with TM participation took place in 2019. Two Masters theses (RWTH Aachen University and Furtwangen University) were successfully

concluded. Work was begun and continued on a doctoral thesis (RWTH Aachen) and on a master's thesis (University of Cologne). This work was closely related to the KATI-tool. Preparation was also begun in 2019 for another master's thesis (Düsseldorf University), in the field »Decision Support«.

- The focus of the **NATO STO Research Task Group SAS-123** »Futures Assessed alongside socio-Technical Evolutions«, in which TM is represented, is on method development and method criticism. In May, the task group met at Fraunhofer INT, and all TASP business units were involved in the central workshop trial.
- In 2019, TM also addressed a number of questions in the key area of **knowledge management**. The information platform »**New Technologies**« is to be re-launched in order to improve its integration into department processes and facilitate its usage. The software behind the institute's internal **wikis**, including the plug-ins used, underwent a test in 2019. For the topic of **project management**, a workshop was held on systematic project conclusion.
- The **Method Forum** was continued. Two events were held, and the topics »The Future Game« (»Zukunftsspiel«) and »Altmetrics & Co« provided the opportunity to discuss and try out new methods and tools.

BUSINESS UNIT »NUCLEAR SECURITY POLICY AND DETECTION TECHNIQUES – NSD«

Dr. Theo Köble

The Business Unit »Nuclear Security Policy and Detection Techniques (NSD)« conducts theoretical and experimental research in nuclear security and nuclear detection methods. Besides fundamental studies, research projects are undertaken for industrial clients and public authorities. In addition, NSD intensifies and expands the national capacity to judge nuclear and radiological weapons and associated asymmetrical threats.

A high-performance Linux cluster is used to simulate physical processes. Besides coupled neutron and gamma transport calculations, NSD also performs coupled neutron and hydrodynamics calculations. For experimental work, the Business Unit operates several neutron generators (14 MeV and 2.5 MeV) and two isotope laboratories. A large variety of radioactive radiation measuring instruments, especially for use in on-site measurement, is available for testing and comparison. Test systems are also available for static and dynamic tests of radiation measuring systems according to standards.

In the area of nuclear disarmament and possible proliferation, NSD continuously observes political and technological developments, especially as seen from the physical-technical perspective. The Business Unit is collaborating with ESARDA (European Safeguards Research and Development Association) and INMM

(Institute of Nuclear Materials Management), and participates in technical preparation work for the Comprehensive Nuclear Test Ban Treaty (CTBT). NSD is also a partner in international projects concerned with CBRNE threats (incidents with chemical, biological, radiological, nuclear or explosive materials).

Science Festival »Highlights of Physics«, 19 – 21 September, 2019, Bonn

The business Unit NSD was present at the exhibition of the science festival »Highlights of Physics« in 2019, staged in Bonn by the Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung, BMBF), the German Physical Society (Deutsche Physikalische Gesellschaft, DPG), and Bonn University. With the title »No Chance for Nuclear Smuggling«, NSD presented its static test system for qualifying



portable measuring devices that identify nuclear material. In addition, a selection of NSD's own measuring devices was shown and their function was explained on request. Centrally sited at Bonn's Münsterplatz, the event attracted many visitors. There was lively interest in the static test system, especially in the measuring devices on display and on general questions regarding radioactivity.

Using the dynamic testing system to qualify an Arktis Portal Monitor

NSD's dynamic testing system, developed as part of the European Commission's project »ITRAP+10 Phase II« and implemented for the first time, was used to characterize a portal monitor from the company Arktis. The test system consists of a source vehicle, motor and control system, the operating software for remote control, and a video system for data storage and remote display. Figure 1 shows a screenshot of the video system during measuring. With or without shielding, the radioactive material can be sent past the subject monitor at different heights and given speeds (0.02 m/s to 2.2 m/s). A 44 m monorail is currently available. The testing system is transportable and can thus be used at many locations.

The Arktis portal monitor was tested with different nuclides for different specifications. Figure 2 shows the source vehicle and its structure. As well as videos from various perspectives, the measuring system display is also integrated.

Development of the dynamic test system was in part owed to experience that NSD gained in work on other EU projects. The qualification of measuring technology using this system is also of interest to the European Commission. Hitherto, the system has enabled the qualification of portal monitors for pedestrians. The next step is to adapt the system to meet test requirements for vehicles.



1 Screenshot of the control monitor of the video surveillance system, with videos from different perspectives and the display of the measurement system during measurement with the portal monitor.

2 Source vehicle of the dynamic test system, running along a monorail. Visible between the vertical tubes is the holder on which a source is inside a PE shield – the white block above the banner.



BUSINESS UNIT »ELECTROMAGNETIC EFFECTS AND THREATS – EME«

Dr. Michael Suhrke

With basic funding from the Federal Ministry of Defence (BMVg), the Business Unit Electromagnetic Effects and Threats (EME) is tasked with further developing the capacity to evaluate electromagnetic effects in the case of a military threat. As there are limits for this task in the BMVg itself, EME conducts its own theoretical and experimental research in consultation with the Ministry and in cooperation with the defense industry. This includes work on further developments in measurement technology. Over and above basic-funded research and contract research projects for the BMVg, commissions from non-defense clients (civil security research) and industrial projects are also important.

The unit's experimental work on electromagnetic threats, especially from High Power Microwaves (HPM), includes investigations into the coupling of electromagnetic fields into structures and specific systems, as well as studies on the vulnerability of electronics through high-intensity fields (High Power Electromagnetics, HPEM). The test subjects range from IT equipment and systems based on current technology, especially on wired and wireless data transmission technology (network engineering), to civilian communications and components of critical infrastructure. Basic research and experimental work also continues on detection methods for electromagnetic threats, in particular from HPM.

The unit has a self-developed TEM waveguide (Transverse Electromagnetic Mode) at its disposal, housed in a hall shielded against frequencies up to several Gigahertz. In a wide frequency range,

this allows linear coupling measurements for determining transfer functions, as well as studies on electromagnetic compatibility (EMC). Also possible is the investigation of interference susceptibility with constant and pulsed fields of strengths up to several kilovolts per meter (kV/m) on objects with dimensions measuring up to several meters. For measurement work outside the institute, EME can make use of a self-developed mobile HPM irradiation facility. With the use of various antennas over a wide frequency range, this facility can also generate field strengths of several kV/m. These systems are supplemented by a reverberation chamber equipped with high-power sources for generating even higher field strengths in the gigahertz range, to reflect the growing number of applications in modern sensor and communications technology in these frequency ranges. Additionally available are a small anechoic chamber and ex-



tensive high frequency and microwave measurement equipment.

As part of the research conducted for BMVg in 2019, work continued on a project to develop an HPEM detector, an assignment from the Bundeswehr Research Institute for Protective Technologies (WIS) in Munster. In this project, investigation continued into the generation dependence of HPEM susceptibility in electronics. In addition, a study analyzed interference susceptibility in sensors. As part of a Technical Agreement on the Development of High Power Microwave Test Methodology and Procedures, cooperation with FOI in Sweden continued in HPEM test methodology in 2019. In addition, a reference test setup for these investigations was presented at the 2019 EMC Europe Conference, held in Barcelona. A project on UAS-HPEM interaction studies for counter-UAS systems, commissioned by the Bundeswehr Technical Center WTD 81, was also started. Results of UAS studies were presented at the DWT »Unmanned Systems« Conference in Bonn.

Also launched in 2019 was the EU-project ETN Marie Curie »Pan-European Training, Research and Education Network on Electromagnetic Risk Management – PETER«, in which EME is one of 19 partners. Within the Fraunhofer Young Research Class 2019 program titled »Resilience of Critical Infrastructure«, a young EME scientist is participating in the project »SMART-KRIT – Smart Adaptive Energy Management in Crisis Using Existing Autonomous Transport System Fleets«.

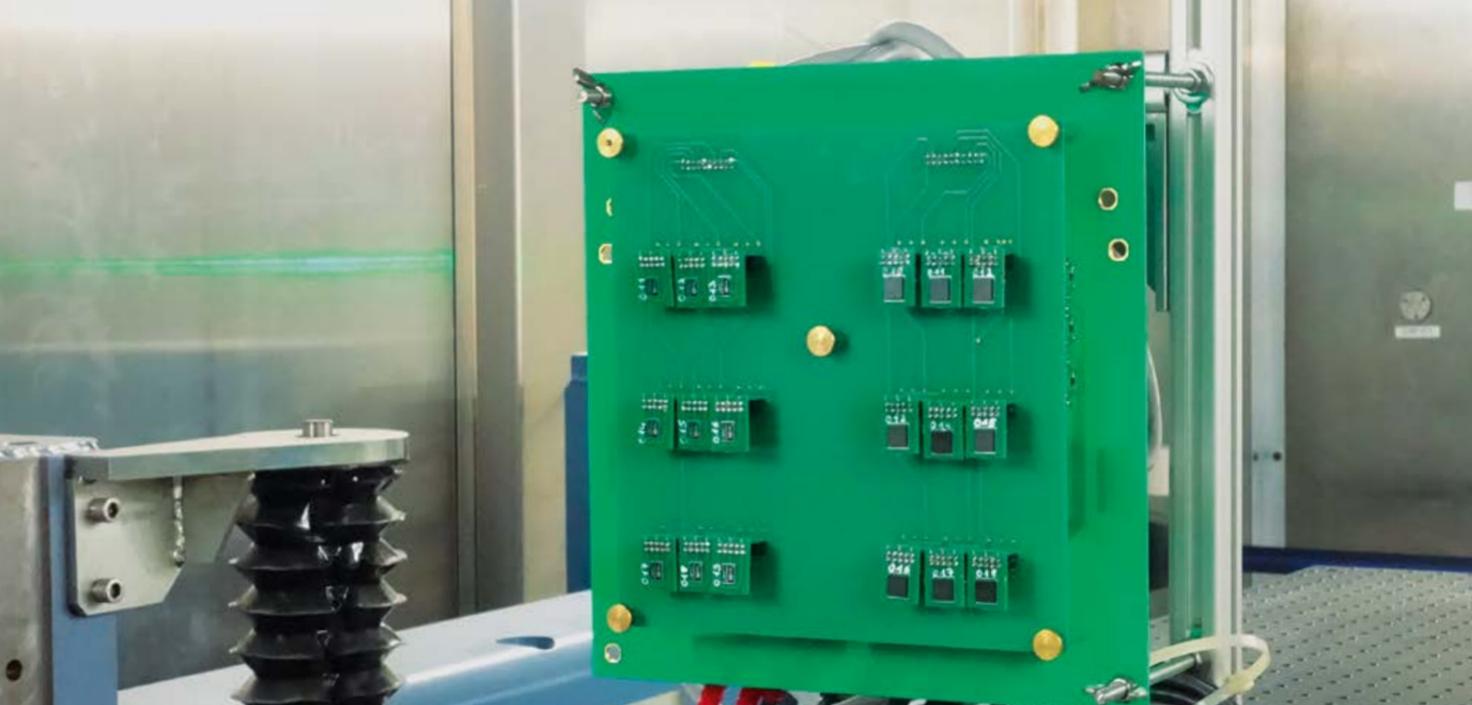
In 2019 work also continued on tasks in the NATO STO SCI-294 Task Group »Demonstration and research of effects of RF Directed Energy Weapons on electronically controlled vehicles, vessels and UAVs«. In the course of the year, an RF-DEW Capability Demonstration for Counter-UAS Applications was conducted at the NATO Missile Firing Installation (NAMFI) on Crete.

Work also began in 2019 on a project to construct an anechoic chamber as a new test environment for the business unit, co-financed from the Fraunhofer-Gesellschaft's central strategy fund.

In standardization, EME is active on a wide scale. This includes the DIN working groups TEM Waveguide and Reverb Chamber, the VG (German defense equipment) standards boards on NEMP and lightning protection, and on electromagnetic compatibility. The unit is also national representative on the IEC's Joint Working Group »Reverberation Chamber«. Further development of HPEM standardization with the goal of a NATO HPEM Protection Guide continues to be a subject for the NATO STO SCI-294 Task Group – as was the case for the previous group.

In EME last year, work continued on a doctorate on the HPEM vulnerability of the smart grid. Using the example of the smart grid, results for evaluating the resilience of critical infrastructures against Intentional Electromagnetic Interference (IEMI) were presented at the EMC Europe 2019 conference in Barcelona.

1 Overview of the drones examined at Fraunhofer INT



BUSINESS UNIT »NUCLEAR EFFECTS IN ELECTRONICS AND OPTICS – NEO«

Dr. Jochen Kuhnhehn

Fraunhofer INT's Business Unit »Nuclear Effects in Electronics and Optics (NEO)« is specialized in the effects of ionizing radiation on electronic, optoelectronic and optical components and systems. NEO conducts radiation tests in accordance with recognized standards and advises companies in radiation qualification and hardening, for example for satellites or accelerators. Lessons learned are also used in the development of radiation sensors. Radiation tests are mainly carried out in INT's own facilities, although external facilities are also used. Unique in Europe, INT's radiation facilities make it possible to recreate in the laboratory all radiation types and the effects they induce, again for example on satellites. In addition, NEO has the latest available technology for measuring even the smallest changes in parameter characteristics.

In 2019, in addition to intensified work in single event effects (SEE), NEO pressed ahead with the investigation of radiation effects in commercial electronic components (commercial off the shelf, COTS). In this area, the Business Unit won an ESA project worth more than € 1 million, titled »Radiation characterization and functional verification of COTS components for space applications (RACOCO)«. Within the scope of this activity, methods to investigate the radiation sensitivity of COTS components more efficient are being developed and verified, with the aim of testing the suitability of a component more cheaply, quickly and nevertheless reliably. The subject of COTS components was taken up in an article in the Fraunhofer

Magazine »weiter.vorn«, and was the focus of the workshop »Herausforderung Weltraum (Space Challenge)«, staged by NEO.

Investigation of SEE in GaN components irradiated by particles

For some time now, constantly improving technology has made it possible to manufacture power electronic components from gallium nitride on silicon. New doping methods allow a self-blocking type of power transistors. These are significantly smaller



and lighter, but can switch large voltages. For safety-relevant applications on Earth, it is necessary to test component sensitivity to terrestrial radiation. As part of a PhD thesis, three different, gallium nitride-based, commercial power transistors of different designs were tested at different ion and neutron facilities, to assess their radiation sensitivity to single event effects (SEE). In a SEE, a single particle (neutron or ion) deposits so much energy in the component that there is a destructive breakdown of the electrical field and, in the worst case, the component is completely destroyed. To investigate this, a circuit board was developed on which three components were operated in reverse direction and their leakage currents were measured while the set-up was in the particle beam. A SEE becomes apparent through a sudden increase in the drain-source leakage current when the electric field is breached, which normally means the destruction of the component. It is assumed that the components react more sensitively the higher the voltage applied.

To be able to draw conclusions about radiation sensitivity, this set-up had been irradiated with different particles and particle energies in four different accelerators: the Grand Accélérateur National d'Ions Lourds (GANIL) in Caen (FR), the ISIS Neutron and Muon Source in Appleton (UK), the particle accelerator CERN in Geneva (CH) and the in-house neutron generator at Fraunhofer INT. Distributions were as follows: at GANIL with Xe ions (LET (Si) between 27–60 MeV cm²/mg), at CERN with Pb ions (LET (Si) 7 MeV cm²/mg), at ISIS with neutrons whose energy distribution corresponds to the spectrum of atmosphere, and at INT with neutrons at 14.5 MeV.

During measurement, the various particle types showed clear differences in SEE sensitivity. While the unopened components at GANIL showed initial failures at low fluences (approx. 105 particles / cm²) at already 60 % of their nominal voltage, CERN measurements showed no failures even at 110 % of nominal voltage and higher fluences (approx. 109 particles / cm²). Here, the penetration depth of the ions and the deposited energy per distance make the main difference.

Also with neutron measurement at ISIS, component failures could only be observed when significantly above the operating voltage (130 %) specified in the data sheet. There were clear differences in the sensitivity of the various component types. Components with a cascade structure (an upstream silicon MOSFET) were found to be significantly less sensitive than components with only one specially doped HEMT structure. When measuring with the 14.5 MeV neutrons, it was observed that all component types only became sensitive at higher voltages (130 % and more of the component's nominal voltage). On average, the components withstood fluences of around 109 neutrons / cm².

The reason for the different sensitivity of the components (all of which are HEMT structure-based) seems on the one hand to be the different design, while on the other hand there are indications that different gate materials lead to different nuclear reactions and secondary particles in the component, thus explaining varying sensitivity. A more detailed investigation of the gate sensitivity is planned, using the microprobe at the GSI Helmholtz Centre for Heavy Ion Research in Darmstadt.

SCIENTIFIC-TECHNICAL SUPPORT

Peter Clemens



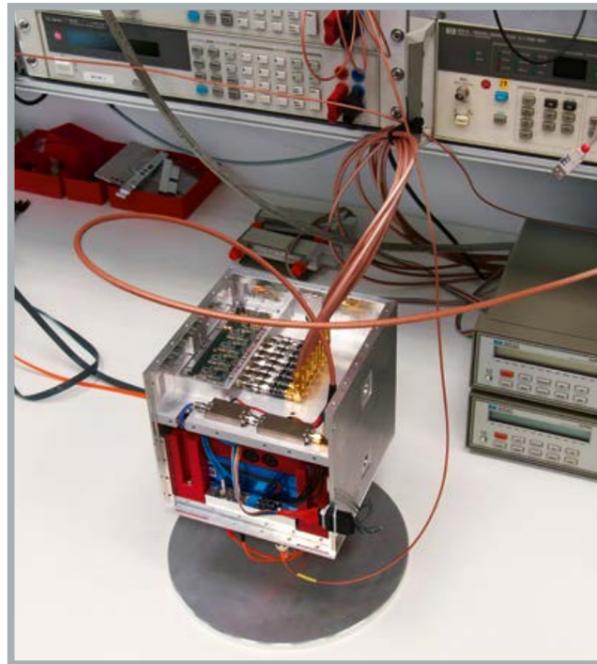
The Department Nuclear and Electromagnetic Effects (NE) has an extensive scientific-technical infrastructure that supports the experimental work in its three Business Units NSD, NEO and EME. The section Scientific-Technical Support (Wissenschaftlich Technische Infrastruktur, WTI) has a precision engineering laboratory which makes special mechanical parts for experimental apparatus. Its electronics laboratory also produces special electronics for experiment work, and carries out servicing and repairs.

Mechanical Workshop

The mechanics of a measuring system were developed as part of an internal project for a Bachelor Thesis entitled »Structure and Evaluation of a partially automated Calibration System for validating a Waveguide as a Test Environment«. The system automatically moves a probe to measure the electric field strength on the X and Y axes. Since metallic components cause interference in the field, it is necessary to use plastic. During design, the fact that plastic bends over greater lengths has to be considered.

Electronics Workshop

In 2019, work continued on the project »WIS-HPEM Detector Next Generation«, which runs from 2018 to 2020. The detector can be used to detect electromagnetic fields with very high field strengths in terms of amplitude, frequency and direction. The project includes the development of extensive hardware development, as well as of the control software. System performance, especially the possibility of measuring even higher frequencies, was considerably enhanced.



The Secretariat supports Department NE:

- with organizational support for projects
- when reporting on experimental research
- in radiation protection
- through cooperation in preparing and conducting workshops
- in drafting questionnaires (also online)

DEPARTMENT BUSINESS ADMINISTRATION AND CENTRAL SERVICES

Prof. Dr. Harald Wirtz

The Department Business Administration and Central Services is responsible for all commercial and administrative tasks, and also provides the Institute's central infrastructure.

The Department subdivides into Finance, Human Resources and Law (FPR), and Central Infrastructure (ZI). These services are rounded off by the independent Library and Specialized Information Services, as well as Marketing and PR.

The **Finance, Human Resources and Law** group is responsible for purchasing, book-keeping, accounting, controlling, human resources and travel and event management. In the year under review, a newly implemented quality management system was used to evaluate, improve and document commercial processes.

The **Central Infrastructure** Group deals with 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.

Marketing and Public Relations manages all necessary communications and marketing work for the products of INT's business units. In recent years, this group has also organized and coordinated the increasing number of INT appearances at key specialist and industrial fairs, such as at the Hannover Messe.

Predominant tasks for the **Library and Specialized Information Service** are procuring and managing the media that the Institute requires, and supporting the scientists in their research work and accessing information for them. Depending on project needs, licenses are acquired for further specialized databases and other information sources, which are then made available. To meet new requirements from public sponsors, the library service also advises and assists project teams with their publication work.

FRAUNHOFER SPACE ALLIANCE

Thomas Loosen

The Fraunhofer Space Alliance is a coalition of 17 Fraunhofer institutes that develop technologies for space applications. Among other things, the formation of the Alliance at Fraunhofer serves to pool expertise in a specific technology field or industry. This creates synergies, making us visible to our partners as well as in identifying complementary skills. The Fraunhofer Space Alliance sees itself as a technology partner for German and European space players, from space agency to start-up.

Fraunhofer has 72 institutes and 27,000 staff, so from the outside it is not always easy to find the right contact person for your interests. The same goes for the Alliance and its 17 members.



To help point the client in the right direction, the Alliance has pooled its resources in six areas, each with its own contact person:

- Communication and Navigation
- Materials and Processes
- Energy und Electronics
- Surface and Optical Systems
- Sensor Systems and Analyses
- Protective Technologies and Reliability

Since its foundation in 2014, the Space Alliance organization has been located at Fraunhofer INT in Euskirchen. Alliance Spokesman is Prof. Dr. Dr. Michael Lauster, Institute Director.

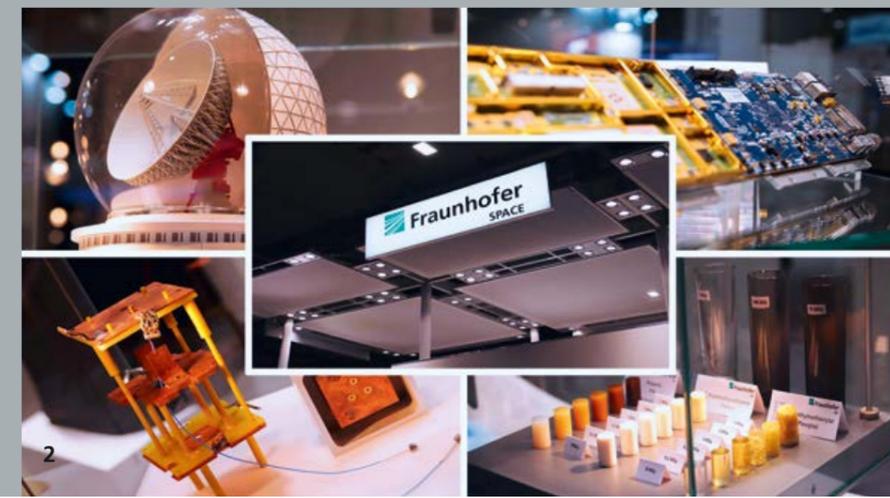
The location at INT provides direct proximity with the Business Unit »Nuclear Effects in Electronics and Optics (NEO)«, which tests components and systems for use in radiation environments. A large proportion of the tests undertaken is irradiation for space projects.

Since one of the main purposes of Fraunhofer's alliances is building up networks, the Space Alliance was again present at numerous trade fairs and conferences in 2019. Of these events, the largest was definitely the Paris Air Show at Le Bourget in June, where five Space Alliance institutes teamed up with several Fraunhofer aerospace institutes at the joint booth of the German Aerospace Industries Association (Bundesverband der Deutschen Luft- und Raumfahrtindustrie, BDLI). Equally noteworthy is the Space Tech Expo in Bremen, staged in November. The third in its history, this fair has established itself as a valuable event for the Alliance, since technology experts among space players and their suppliers use it as an exchange platform. With eight institutes, the Alliance was well represented at a large booth.

In September, a technology conference was held at ESA's European Space Technology Center (ESTEC) in Noordwijk, Netherlands. As well as a series of workshops on strategic technology themes, selected technology highlights were displayed in a small exhibition in the entrance to the ESTEC canteen. This was an excellent opportunity for the Alliance to talk directly to ESA employees about technology needs. More such events are being planned.

Another event of great importance was a technology workshop together with OHB System AG, staged as part of the Space Tech Expo in Bremen. Here, too, there was a lively discussion on technology supply and demand, with further meetings to follow – each focusing on a specific technology.

Particularly gratifying was the addition of two new institutes to the Space Alliance: Fraunhofer IWS and Fraunhofer CAP. The Fraunhofer Institute for Material and Beam Technology



(Fraunhofer-Institut für Werkstoff- und Strahltechnik IWS) is largely concerned with generative manufacturing, and the Fraunhofer Center for Applied Photonics CAP in Glasgow mainly focuses on optics. CAP is the first Alliance member that is not based in Germany.

Members

- Fraunhofer Institute for Applied Optics and Precision Engineering IOF
- Fraunhofer Institute for Chemical Technology ICT
- Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM
- Fraunhofer Institute for High Frequency Physics and Radar Techniques FHR
- Fraunhofer Institute for Integrated Circuits IIS
- Fraunhofer Institute for Communication, Information Processing and Ergonomics FKIE
- Fraunhofer Institute for High-Speed Dynamics EMI
- Fraunhofer Institute for Laser Technology ILT
- Fraunhofer Institute for Heinrich-Hertz-Institute HHI
- Fraunhofer Institute for Technological Trend Analysis INT
- Fraunhofer Institute for Open Communication Systems FOKUS
- Fraunhofer Institute for Optronics, System Technologies and Image Exploitation IOSB
- Fraunhofer Institute for Surface Engineering and Thin Films IST
- Fraunhofer Institute for Solar Energy Systems ISE
- Fraunhofer Institute for Microengineering and Microsystems IMM
- Fraunhofer Institute for Material and Beam Technology IWS
- Fraunhofer Centre for Applied Photonics CAP

1 and 2 Impressions of the booth at the Space Tech Expo Europe 2019 in Bremen

CHAIR AT RWTH AACHEN UNIVERSITY

Christian Hemmers, Stephanie Hansen-Casteel

At the RWTH Aachen University, content and methodology work in the Professorship for Technology Analysis and Foresight in Security Research again continued in the year under review. The purpose of the chair is to provide university students with quantitative and qualitative methods for researching the future, particularly in the context of application-oriented teaching and learning concepts. Concentrating on suitability and optimization aspects of future research, this includes both underpinning epistemological methods and examining the methods spectrum.

The chair focuses on the analysis of forecasting processes in technology, as well as on the adaptation, development and improvement of appropriate procedures and methods. Findings from continuously generated research provide the support for scientific decision-making in technology as it evolves over time.

Teaching is offered in lecture form during semester time, or in one or two-day block courses (seminars). In the 2019 summer semester, the lecture »Methods of Future Research – Technology Analysis« was attended by 83 students. In the winter semester 2019/2020, 134 students attended the lecture »Methods of Future Research – Technology Foresight«. Apart from the lectures, seminars are also offered to deepen lecture content. The »Technology Ethics« seminar was held for the first time in the summer semester, while the »Science and Epistemology« seminar was again held during the winter semester. Since the seminars are proving very popular alongside the lectures, new seminar formats are to be added in the coming academic year. To this end, a »Security Research« seminar is being developed for the summer semester, as well as a seminar on »Data Driven Foresight« for the winter semester.

Feedback from participants shows that the range of courses is seen as a useful, attractive addition to what is predominantly a technology and business studies curriculum. Over and above the main theme, there are exercises to address the demand for training in communication and presentation skills – an area



given only little space in the remaining syllabus owing to the high number of students.

Already for the fourth year in succession, the incumbent chair, Prof. Dr. Dr Michael Lauster cooperated with Prof Dr. Dr. Axel Zweck (Sociology Chair at RWTH Aachen University), to conduct a cross-discipline seminar, titled »(Inter)Disciplinary Future – Tomorrow's Technologies from the Social and Engineering Views«. The basic concept is for students of engineering to collaborate with sociology students in producing an assessment of the consequences of technology. The seminar's goal is to analyze the varying views from each science field and to open up student awareness of the other view. The closing event, which gave the groups a platform for presenting their results, took place on the premises of Fraunhofer INT in July 2019.

Another success was the lecture series »Methods of Researching the Future«, established at the Ravensburg-Weingarten University. The lectures, given by Prof. Lauster, present students of the Technology Management Faculty with an application-based insight into the methodological principles of researching the future. The series takes place in block form once a year in Weingarten, and finds positive student response.

In 2019, the cooperation between the chair and Fraunhofer INT was further enhanced. Scientists at Fraunhofer INT are increas-



ingly supporting the teaching work and, conversely, Bachelor and Master thesis students have been won over to Fraunhofer INT. Internships and assistant research jobs were also taken up by course students.

Prof. Dr. Dr. Lauster is supervising two dissertations: work on the paper »Technology Acceptance« has developed a set of indicators for the prospective measurement of technology acceptance and is close to completion, while another dissertation, looking at foresight processes for SMEs, has been in process since 2019.

1 Lecture Hall at RWTH Aachen University

2 Prof. Dr. Dr. Lauster lecturing at RWTH Aachen University

SHORTLY NOTED

Angelique Makome, Gina Frederick

Extensions to INT Experiment Hall

On February 11, 2019, work began on extension work for the experiment hall at Fraunhofer INT. The Department Nuclear and Electromagnetic Effects will be using the new space for researching special Electromagnetic Compatibility (EMC) questions.

The new construction is an extension of the southern, low-level section of the experiment hall, which for 40 years has been exclusively used for research in electromagnetics. The extension will be adding another 110 m². Most of the new space will be taken up by a new anechoic chamber, in which 170 m³ will be available for research in special EMC questions in the future.

As well as the anechoic chamber, there will also be an amplifier room; both rooms will be equipped with the latest technology and reliable shielding. Investment in the new hall will total well over one million euros.

Hannover Messe 2019

Fraunhofer INT was again present at the Hannover Messe, where the latest exhibits and technologies were on show at the joint Fraunhofer-Gesellschaft booths.

Altogether, the Fraunhofer-Gesellschaft mounted three joint booths, with 46 Fraunhofer organs exhibiting on a total area of 1,338 m². Fraunhofer INT's exhibits were part of the largest joint Fraunhofer booth, located in Hall 2 and devoted to Research and Technology.

For more than 45 years, Fraunhofer INT has been analyzing future technologies, supporting the scientists with the help of KATI (Knowledge Analytics for Technology and Innovation). KATI is an IT and data-based assistant system that Fraunhofer INT is developing as part of a research project, aimed at making



literature research for technology forecasting more efficient. As in the previous year, the system aroused great interest among visitors.

New for the Hannover Messe this year was the first-time presentation of our future game. The game was developed as part of the project »WIDENING HORIZONS – CHANGING PROSPECTS«, which deals with developing technologies for remote areas beyond the limits of an agglomeration. With a new approach to gaming and simulation, our scientists discussed with visitors at the Fair, playfully finding out what society finds important when it comes to new technologies. This is important, first, to develop the right research strategy and second, to develop needs-based technologies.

Celebrating 45 years of Fraunhofer INT – from university project group to independent Fraunhofer Institute

The Fraunhofer Institute for Technological Trend Analysis INT celebrated its 45th anniversary in 2019. Before becoming part of the Fraunhofer-Gesellschaft in 1974, INT was the Institute for Radiation Protection at Kiel University. Relocation from Kiel to Euskirchen began in 1977, in order to be closer to the main client, the Federal Ministry of Defense (BMVg). Today, INT has

a staff of 120, and in addition to purely military research, civil projects also play a large role.

To mark the anniversary, Institute Director Prof. Dr. Dr. Michael Lauster reviewed the past, but also focused on the Institute's future. »This year, INT looks back on 45 eventful years, characterized by the relocation to Euskirchen, by growth and success, but also by the challenges that we mastered together. In the future, too, we shall continue to focus our efforts on being an excellent research partner, making our powers of technological judgment and advice available to our clients. Our circle of partners is constantly expanding, and includes both public and private sectors. In the next few years, we intend to place a special focus on promoting young scientists, to which end we shall be expanding cooperation with the region's universities and colleges, and strengthening our presence there. Together with my colleagues, I look forward to taking up the exciting challenges of the coming years.«

Scholars' Contest ANTalive 2019

In 2019, Fraunhofer INT and ten further organizations in the region Euskirchen, Aachen and Düren again took part in the contest »Go-Ing & Go-Job«, run by the zdi-Zentrum ANTalive (Center for the Future through Innovation). Shortly before their summer vacation, pupils are given the opportunity of taking a look inside a company and working on realistic projects as contest tasks. This gives them an idea of what can come their way after gaining university entrance qualification. As in previous years, senior scientist Jürgen Kohlhoff supervised the three scholars in the group. At the contest's final presentation in the Sparkasse Düren on July 8, 2019, the team succeeded in securing second place.

Under the heading »Technology Advice for Decision-Makers«, the pupils assume the position of assistant to a board of management. The set scenario was a board meeting that had to



decide on a major investment for developing personal robots. In advance of the meeting, the students had to write a recommendation that assessed chances and risks, taking account of social acceptance and legality.

The 2019 contest was the sixth in a row. The pupils spend a week in selected companies, where, in small mixed groups, they are given realistic project tasks. In working out their solutions, they have a chance to show their skills in logical thinking and creativity. The contest also aims at introducing the students to the »MINT« professions (jobs in Mathematics, IT, Science and Technology).

1 Joint Fraunhofer booth at the Hannover Fair 2019

2 Final presentation of the scholars' competition in the Sparkasse Düren

The 2019 Bonn Company Run

For the first time, eight staff members from Fraunhofer INT took part in the 2019 Bonn Company Run. Five more of the region's Fraunhofer Institutes (FHR, FKIE, FIT, IAIS and SCAI), together with staff from Fraunhofer Headquarters, had come together to form a combined Fraunhofer team. With 110 starters, Fraunhofer was honored at the subsequent award ceremony for the high number of participants.

The 2019 Bonn Company Run was already the 13th. A total of 11,323 running enthusiasts from 419 companies in Bonn and its surrounding area met for the start in the »Rheinaue« – Bonn's riverside meadow zone - on September 12. Numerous music groups lined the route to encourage the runners.



At the start-and-finish, there was a stage, food booths and an area that offered free massages. Subsequently, honors went to the teams with the largest participant numbers in relation to a company's total staff.

As well as the largest teams in number, the teams wearing the most original running outfits were picked out. Charity was again the main focus for this year's Bonn Company Run: donations totaling 21,000 euros went to the Verein Mukoviszidose (Cystic Fibrosis Foundation) and to Care Germany-Luxembourg.

The Bonn Company Run takes place annually under the motto »RUN AS YOU ARE or (in Rhenish dialect) LOOF WIE DE BESS«. The 5.7 km course runs through the site of the former Federal German Garden Show.

3 Combined Fraunhofer-Gesellschaft team at the Bonn Company Run 2019

APPENDIX

University Courses, Lectures and Exercises

Alessi, A.: Lecture »Microelectronic and optical components in space environments«, Palermo Maggio 2019, University Palermo, Italy, 5/5 – 6/2019

Bantes, R., Wiemken, U.: Lecture »Technik und Gesellschaft« in the Bachelor Degree course »Technikjournalismus«, Bonn-Rhein-Sieg University of Applied Sciences, winter term 2019/2020

Bantes, R., Wiemken, U.: Lecture »Technik und Gesellschaft« in the Master Degree course »Technik- und Innovationskommunikation«, Bonn-Rhein-Sieg University of Applied Sciences, winter term 2019/2020

Chmel, S.: Lecture and exercise »Physics« in the Bachelor Degree course »Naturwissenschaftliche Forensik« (2nd semester), Bonn-Rhein-Sieg University of Applied Sciences, summer term 2019

Chmel, S.: Lecture and exercise »Measuring Techniques« in the Bachelor Degree course »Naturwissenschaftliche Forensik« (3rd semester), Bonn-Rhein-Sieg University of Applied Sciences, winter term 2019/2020

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, 4/8/2019

John, M.: »Das Cochlea Implantat: Funktionsweise, Entwicklung, Chancen, Risiken und Erfahrungen im Hinblick auf die logopädische Praxis«, IB-Medical Academy, School for Logopaedia, Berlin, 3/4 – 6/2019

John, M.: »Quantitative Methoden der Zukunftsforschung. Eine sehr kurze Einführung in Data Driven Foresight«, as part of the Lecture »Methoden der Zukunftsforschung II«, »RWTH Aachen University, 5/14/2019

Kohlhoff, J., Hemmers, C.: Exercise »Methoden der Zukunftsforschung« in the Master Degree course »Technologie-Management & Optimierung«, University of Applied Sciences Ravensburg-Weingarten, Weingarten, 5/22/2019 – 5/24/2019

Lauster, M.: »Methoden der Zukunftsforschung I«, RWTH Aachen University, winter term 2019/2020

Lauster, M.: »Methoden der Zukunftsforschung II«, RWTH Aachen University, summer term 2019

Lauster, M.: »Erkenntnis- und Wissenschaftstheorie für Ingenieure«, RWTH Aachen University, winter term 2019/2020

Lauster, M.: Common seminar engineers/sociologists about technology assessment, RWTH Aachen University, summer term 2019

Lauster, M.: Seminar »Technikethik«, RWTH Aachen University, summer term 2019

Lauster, M.: Lecture »Methoden der Zukunftsforschung«, University of Applied Sciences Ravensburg-Weingarten, Weingarten, summer term 2019

Metzger, S.: Lecture »Experimental Techniques in Particle Physics« in the Master Degree course »Physics«, RWTH Aachen University, winter term 2019/2020

Schulte, A.: »Methoden der Zukunftsforschung II«, RWTH Aachen University, summer term 2019

Sturm, F.: Lecture »The scenario technique as a forecasting method: application in the agribusiness«, in the Master Degree course »Agricultural and Food Economics«, University of Bonn, 1/7/2019

Wirtz, H.: »Finanzierung und Investition« in the Bachelor Degree course »Automotive and Mobility Management«, Hochschule Fresenius, winter term 2018/19

Wirtz, H.: »Qualitäts-, Change und Innovationsmanagement« in the Bachelor Degree course »Betriebswirtschaftslehre«, Hochschule Fresenius, winter term 2018/19, summer term 2019, winter term 2019/20

Wirtz, H.: »Qualitäts-, Change und Innovationsmanagement« in the Bachelor Degree course »Betriebswirtschaftslehre« (berufsbegleitend), Hochschule Fresenius, winter term 2018/19, summer term 2019, winter term 2019/20

Wirtz, H.: »Controlling und Qualitätsmanagement« in the Bachelor Degree course »Automotive and Mobility Management«, Hochschule Fresenius, winter term 2018/19, summer term 2019, winter term 2019/20

International Cooperation

Alessi, A., Höffgen, S., Kuhnenn, J., Kündgen, T., Lennartz, W., Metzger, S., Paschkowski, E., Schmitz, S., Steffens, M., Weinand, U., Wolf, R., Wölk, D.:
CERN, Geneva, Switzerland

Alessi, A., Höffgen, S., Kuhnenn, J., Kündgen, T., Lennartz, W., Metzger, S., Paschkowski, E., Schmitz, S., Steffens, M., Weinand, U., Wolf, R., Wölk, D.:
ESA-ESTEC, Noordwijk, the Netherlands

Berchthold, C., Grigoleit, S., Müller, L., Sendrowski, P., Vollmer, M.:
Horizon 2020 project IN-PREP (An Integrated next generation PREParedness programme for improving effective interorganisa-tional response capacity in complex environments of disasters and causes of crisis), 19 project partners

Berchthold, C., Sendrowski, P.:
DG ECHO Tender »Network of European Hubs for Civil Protection and Crisis Management«, 5 project partners

Berky, W., Bornhöft, M. C., Friedrich, H., Schumann, O.:
Institut pluridisciplinaire Hubert Curien (IPHC), Strasbourg, France

Bornhöft, M. C., Friedrich, H., Glabian, J., Köble, T., Risse, M., Schumann, O.:
In DG Home pro-ject ITRAP+10-phase-2 (Illicit Trafficking Radiation Assessment Program + 10 phase II Round Robin Tests), 5 project partners

Friedrich, H., Glabian, J., Risse, M. Schumann, O.:
Arktis Radiation Detectors Ltd., Zurich, Switzerland

Grigoleit, S., Müller, L., Walther, G.:
Horizon 2020 Project SHAPES (Smart & Health Aging Promoting Empowering Systems), 36 project partners

Köble, T.:
ESARDA VTM Working Group

Köble, T.:
IAEA Expert Group: Revision of IAEA Nuclear Security Series No. 1, »Technical and Functions Specifications for Border Monitoring Equipment«

Kuhnenn, J., Steffens, M.:
Seibersdorf Labor GmbH, Seibersdorf, Austria

Neupert, U., Ruhlig, K., Brandt, H., Yildirim, B.:
FMV (Försvarets Materielverk)-Project Teknisk Prognos 2019

Pastuszka, H.-M., Klein, M.:
European Defence Agency (EDA), Service Framework Contract »Technology Foresight Follow-on (TFFO)« (17.ESI.OP.373), in cooperation with Ingeniería de Sistemas para la Defensa de España (Isdefe, Spain), 2018–2019, Foresight Workshop on »Quantum Technologies for Defence«, EDA, Brussels, 05/23–24/2019

Pusch, T., Suhrke, M.:
FOI Sweden, Technical Agreement »Development of high-power microwave test methodology and procedures«

Pusch, T., Suhrke, M.:
ETN Marie Curie »Pan-European Training, research and education network on Electromagnetic Risk management – PETER«, 19 project partners

Sendrowski, P., Berchthold, C., Walther, G.:
DG ECHO Tender »Peer Review for Civil Protection«, 3 project partners

Suhrke, M., Adami, Ch.:
Participation in NATO STO SCI-294 Task Group »Demonstration and Research of Effects of RF Directed Energy Weapons on Electronically Controlled Vehicles, Ves-sels, and UAVs«, 9 nations

Vollmer, M., Walther, G., Jovanović, M., Pusch, T., Suhrke, M.:
Participation in EU-H2020 project SmartResilience (Smart Resilience Indicators for Smart Critical Infrastructures), 20 project partners

Walther, G., Neisser, F.:
FIRE-IN (Fire and Rescue Innovation Network) project, 16 project partners

International Reviews

Alessi, A., Kuhnhenh, J., Steffens, M.: Transactions of Nuclear Science

Alessi, A., Kuhnhenh, J.: Journal of Lightwave Technology

Alessi, A.: Applied Optics

Alessi, A.: Applied Sciences

Alessi, A.: Electronics

Alessi, A.: Europhysics Letters

Alessi, A.: Journal of Alloys and Compounds

Alessi, A.: Journal of Non-Crystalline Solids

Alessi, A.: Journal: Radiation Physics and Chemistry

Alessi, A.: Materials

Alessi, A.: Materials Chemistry and Physics

Alessi, A.: Optical Materials Express

Alessi, A.: Sensors

Alessi, A.: The Journal of Physical Chemistry

Kuhnhenh, J. NSREC 2019 Conference

Kuhnhenh, J.: Optical Fiber Technology

Kuhnhenh, J.: Pazy Foundation

Kuhnhenh, J.: Photonic Technology Letters

Kuhnhenh, J.: RADECS 2019 Conference

Lanzrath, M.: IEEE Transactions on Electromagnetic Compatibility

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

Metzger, S.: IEEE Transactions on Nuclear Science

Metzger, S.: RADECS 2019 Conference

Steffens, M.: Applied Radiation and Isotopes

Suhrke, M.: IEEE Transactions on Electromagnetic Compatibility

Thorleuchter, D.: Applied Sciences

Thorleuchter, D.: Control & Cybernetics

Thorleuchter, D.: Electronics

Thorleuchter, D.: Expert Systems with Applications

Thorleuchter, D.: Information

Thorleuchter, D.: International Journal of VLSI Design & Communication Systems

Thorleuchter, D.: Journal of Ambient Intelligence and Humanized Computing

Thorleuchter, D.: Sensors

Collaboration in Committees

Alessi, A.: Collaboration in Scientific Committee as preparation for the 13th Symposium »Advanced Dielectrics and related Devices«

Chmel, S.: Coordinator of the Fraunhofer EU-Network

Chmel, S.: Head of work group »Management« of the Fraunhofer EU-Network

Chmel, S.: Member of the advisory board of the Institute for Detection Technologies, Bonn-Rhein-Sieg University of Applied Sciences

Lauster, M.: Chief Scientific Officer Deutsche Gesellschaft für Wehrtechnik

Lauster, M.: Committee »Interne Programme« Fraunhofer-Gesellschaft

Lauster, M.: F&T-Steuerungsboard, BMVg

Lauster, M.: AG F&T-Strategie, BMVg

Lauster, M.: F&T-adviser for F&T-director BMVg

Linde-Frech, I.; Vollmer, M.: EARTO Security and Defense Research Group

Neupert, U.: Weiterentwickler-Netzwerk A 16+ Streitkräftebasis

Suhrke, M.: Ombudsperson Fraunhofer INT

Thorleuchter, D.: Spokesman of the Special Interest Group »Information- and Communication Systems« of the German Computer Society (Gesellschaft für Informatik e.V. (GI))

Thorleuchter, D.: Editorial Board of Advances in Engineering: an International Journal (ADEIJ)

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 Journal of Autonomous Intelligence

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

Thorleuchter, D.: Program Committee of the International Conference on Intelligent Computing in Data Sciences (ICDS) 2019, 28. – 30. 10. 2019, Marrakech, Morocco

Thorleuchter, D.: Program Committee of the International Conference on Machine Learning & Applications (CMLA) 2019, 23. – 24. 11. 2019, Zurich, Switzerland

Walther, G., Neupert, U.: Members of the Independent Scientific Evaluation Group (ISEG) of the NATO-research programme »Science for Peace and Security«

Participation in Norming Processes

Adami, Ch.: NA140-00-19AA

Preparation of VG-Standards VG96900-96907, NEMP- und Blitzschutz

Adami, Ch.: NA140-00-20-02UA

Preparation of VG-Standards VG95370 ff., Elektromagnetische Verträglichkeit

Adami, Ch.: NATO HPM Standardization (NATO STO SCI-294 Task Group)

Köble, T.: DIN und VDE DKE/GK851 »Aktivitätsmessgeräte für den Strahlenschutz«

Köble, T.: IEC/SC 45B WG 15 »Radiation protection instrumentation« – »Illicit trafficking control instrumentation using spectrometry, personnel electronic dosimeter and portable dose rate instrumentation«

Neisser, F.: DIN SPEC 91390

Integriertes Risikomanagement im Bevölkerungsschutz

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

Suhrke, M.: GAK 767.3/4.4

TEM-Wellenleiter/Reverberation Chamber, DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE

Lectures and Presentations

Adami, Ch.:

»Drohnenabwehr durch High Power Electromagnetics (HPEM)«, DWT-Conference »Unbemannte Systeme«, Bonn, 06/04 – 05/2019

Alessi, A.:

»Basic characterization of optical fibers«, Lecture at International Symposium on Reliability of Optoelectronics for Systems (ISROS) 2019, Toulouse, France, 11/26 – 29/2019

Bantes, R., Neupert, U. Pastuszka, H.-M.:

»Future Topics Defence Technologies Forecast - WTV 2018«, 2. R&T Futures Situation Conference BMVg A II, Fraunhofer INT Euskirchen, 02/19/2019

Höffgen, S.:

»Einzelteilcheneffekte in Halbleitern«, Lecture at Workshop »Herausforderung Weltraum«, Euskirchen, 11/13/2019

John, M.:

»Lessons Learned from KATI: What about Watson?«, AI-enabled Tech Foresight Summit, Berlin 2/20/2019

John, M.:

»Where do we go tomorrow? Data Driven Foresight – Nutzung IT- und datenbasierter Methoden für die Technologieförderung«, SRH University Heidelberg, Heidelberg, 7/22/2019

John, M.:

»Suchst Du noch oder forschst Du schon? Eine kurze Einführung in KATI«, Coordination Meeting Wehrwissenschaftliche Ressortforschung, Karlsruhe, 10/15/2019

Jovanović, M.:

»Bibliometrics and bibliometric analyses – Possibilities and limitations«, annual meeting of the working committee of libraries and information facilities of the Leibniz Association; Magdeburg, 11/14/2019

Köble, T.:

»Von der He-3-freien Neutronendetektion zu innovativen neuen Strahlungsdetektoren«, 2019 Expert Conference CBRN Detection, Munster, 09/19/2019

Kuhnhenh, J.:

»Strahlungseffekte in Materialien und optischen Komponenten«, Lecture at Workshop »Herausforderung Weltraum«, Euskirchen, 11/14/2019

Kuhnhenh, J.:

»Commercial off the Shelf Components«, Lecture at ESA-ESTEC, Noordwijk, the Netherlands, 9/30/2019

Kuhnhenh, J.:

»Extreme Radiation Testing«, Lecture at ESA ESTEC, Noordwijk, the Netherlands, 10/01/2019

Kuhnhenh, J.:

»Präsentation der Fraunhofer Allianz Space«, Lecture at ESA TecDays, Munich, 02/12/2019

Kuhnhenh, J.:

»Radiation characterization and functional verification of COTS components for space applications (RACOCO)«, Lecture at 13th ESA Workshop on Avionics, Data, Control and Software Systems (ADCSS), Noordwijk, the Netherlands, 11/13/2019

Kuhnhenh, J.:

»Radiation Effects Testing for Photonics and Space«, Lecture at Laserzentrum Hannover, Hannover, 10/28/2019

- Kuhnhehn, J.:
»Strahlung im Weltraum – Ist der Missionserfolg Glück oder Können?«, Lecture at University Gießen, Gießen, 12/09/2019
- Lanzrath, M.:
»UAS-HPEM-Wechselwirkungsuntersuchungen«, Sachstandsbesprechung HPEM 2019, WTD81 Greding, 12/09-10/2019
- Lanzrath, M.:
»UAS-HPEM-Wechselwirkungsuntersuchungen«, Sachstandsbesprechung HPEM 2019, Diehl Defence Röthenbach, 12/03 – 4/2019
- Lauster, M.:
Vorstellung des INT, Fraunhofer VVS kompakt, BAAINBw Koblenz, 02/04/2019
- Lauster, M.:
»Welche neuen Technologien können die Arbeit der Polizei erheblich verbessern bzw. beschleunigen?«, Behörden Spiegel Symposium »Neue Technologien für die Polizei«, Würzburg, 03/06-08/2019
- Lauster, M.:
»New Space and ALM – A New Era of Production Processes for Space Flight?« Workshop on Technologies for Disruptive Innovation, ESTEC Noordwijk, 03/13/2019
- Lauster, M.:
»Innovation, Disruption, Konfusion - Gedanken über ein Modewort im Kontext von Sicherheit und Verteidigung«, Future Security, Berlin, 03/14 – 15/2019
- Lauster, M.:
»Langfristige Aspekte wehrwissenschaftlicher Forschung und Technologie«, Strategieguppe BMVg Bonn, 05/07/2019
- Lauster, M.:
Impulsvortrag »Human Performance Enhancement, Jahrestagung der Abteilung Planung BMVg«, Berlin, 05/14/2019
- Lauster, M.:
»Autark, autonom, anders: Entwicklungen und Trends bei zukünftigen unbemannten Systemen«, DWT-Tagung Bonn Unbemannte Systeme, 06/04 – 05/2019
- Lauster, M.:
2. F&T-Steuerungsboard, BMVg Bonn, 06/11/2019
- Lauster, M.:
»Die Bedeutung neuer Technologien für Sicherheitspolitik und Streitkräfte«, Klausurtagung des Einsatzführungskommandos der Bundeswehr, Potsdam, 06/18 – 19/2019
- Lauster, M.:
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»Single event sensitivity and de-rating of SiC power devices to heavy ions and protons«, Poster RADECS 2019 Dataworkshop, Montpellier, France

Wölk, D.; Höffgen, S.; Paschkowski, E.; Steffens, M.:

»Single Event Effects by atmospheric neutrons in commercial (COTS) normally-off GaN HEMTs«, Poster RADECS 2019 Dataworkshop, Montpellier, France

Personalia

Bornhöft, M. C.:

Doctoral thesis »Untersuchung neuartiger Detektormaterialien zur gleichzeitigen effizienten Detektion und Identifikation von Neutronen- und Gammastrahlung«, RWTH Aachen University, 2016 – ongoing

Lanzrath, M.:

Doctoral thesis »HPEM-Verwundbarkeit moderner Energieversorgungssysteme«, University Duisburg-Essen, 2015 – ongoing

Vollmer, M.:

Doctoral thesis »Implementing innovations in disaster management to increase resilience – laws, policies, and organizational determinants«, University of Wuppertal, 2016 – ongoing

Wölk, D.:

Doctoral thesis »Untersuchung und Entwicklung von Analysemethoden zu neutroneninduzierten SEE«, University of Cologne, 2017 – ongoing

Other Events

01/24/2019

Defense Technologies Forecast – WTV-Workshop Editions 2018-3/-4 with BMVg, BAAINBw, PlgABw, German Armed Forces at Fraunhofer INT

01/29 – 30/2019

Security Mission Information & Innovation Group (SMI2G) brokerage event, Brussels (Co-organisation)

02/04 – 05/2019

Fraunhofer VVS Compact at BAAINBw Koblenz

02/19 – 20/2019

2. R&T-Futures Situation Conference with BMVg, BAAINBw, PlgABw, UniBw, DLR PK-S, Fraunhofer VVS and ISL at Fraunhofer INT

3/13 – 15/2019

Exhibition booth Future Security 2019, Berlin

3/26 – 28/2019

Meeting NATO CSO SCI-294 Task Group »Demonstration and Research of Effects of RF Directed Energy Weapons on Electronically Controlled Vehicles, Vessels and UAVs«, Stockholm, Sweden

6/4 – 5/2019

Exhibition booth DWT-Conference »Unbemannte Systeme«, Bonn

6/24 – 28/2019

Research-Camp Young Research Class 2019: »Resilienz kritischer Infrastrukturen«, Fraunhofer Forschungscampus, Waischenfeld

7/2 – 3/2019

Meeting NATO CSO SCI-294 Sub Group »NATO Susceptibility Test Procedure Recommendation Against RFW Threats«, Amsterdam, the Netherlands

8/27 – 28/2019

Workshop »Development of High-Power Microwave Test Methodology and Procedures«, FOI, WIS, INT, Euskirchen

09/05/2019

Defense Technologies Forecast – WTV-Workshop Editions 2019-1 and -2 with BMVg, BAAINBw, PlgABw and German Armed Forces at Fraunhofer INT

9/16 – 20/2019

Exhibition booth RADECS 2019, Montpellier, France

9/16 – 21/2019

Exhibition stand »Highlights der Physik«, Bonn

9/17 – 18/2019

Workshop Young Research Class 2019, IESE, IISB, INT, Euskirchen

09/20/2019

Exhibition booth Berufsorientierungsveranstaltung Quo Vadis, Marienschule, Euskirchen

9/24 – 26/2019

9. Symposium Nukleare und radiologische Bedrohungen – Technologische Urteilsfähigkeit und nukleare Sicherheit in Deutschland, Fraunhofer INT, Euskirchen

9/30 – 10/1/2019

Exhibition booth ESA ESTEC, Noordwijk, the Netherlands

9/30 – 2/10/2019

Projektexpo Young Research Class 2019: »Resilienz kritischer Infrastrukturen«, Fraunhofer Fokus, Berlin

10/14–15/2019

Coordination Meeting BMVg Governmental Research 2019 with BMVg, BAAINBw, BMVg Governmental Research Establishments, Fraunhofer VVS, DLR PK-S and ISL at Fraunhofer IOSB in Ettlingen and Karlsruhe

11/19–22/2019

Exhibition booth SpaceTechExpo, Bremen

11/26–27/2019

Berlin Security Conference 2019

12/05/2019

Defense Technologies Forecast (WTV) Themes Workshop for 2020 with BMVg, BAAINBw and PlgABw at Fraunhofer INT

12/18/2019

Fact-finding visit German Institute for Defence and Strategic Studies (FüAkBw-GIDS) at Fraunhofer INT

Press Releases

Institut erweitert Experimentierhalle
02/05/2019

Fraunhofer INT ist erneut Gastgeber der Zukunftslagekonferenz Forschung und Technologie des BMVg
03/19/2019

Zukunftsforschung, neue Technologien und ihre Anwendung in der Gesellschaft
03/21/2019

Das Fraunhofer INT feiert 45-jähriges Jubiläum – von der Universitätsprojektgruppe zum Fraunhofer-Institut
04/25/2019

Was sind die Zukunftsthemen der Angewandten Forschung?
08/12/2019

RACOCO: Strahlungscharakterisierung und Funktionsprüfung von COTS Bauteilen zur Anwendung im Weltraum
10/11/2019

Institute Course

Yildirim, B. (Fraunhofer INT):
»Erosionsschutz in Flugtriebwerken – Lösungsansatz und Potenzial«, Euskirchen, 01/30/2019

Brüggemeier, M. (FKpt, former commander frigate Bavaria):
»Marine im Einsatz«, Euskirchen, 02/06/2019

Reichardt, K. D. (former member of the Bundestag and state parliament of Baden-Wuerttemberg):
»Gesellschaft und Politik – heute und perspektivisch: Ergänzung oder Widerstreit?«, Euskirchen, 02/13/2019

Fekete, A. (TH Köln):
»Macht allein Schaden klug? Wissen, Erfahrung und Lernen im Umgang mit Risiken«, Euskirchen, 02/27/2019

Wölk, D. (Fraunhofer INT):
»Lebensdauerermessung von angeregten Kernzuständen in ¹¹²Te«, Euskirchen, 03/13/2019

NATO Command and Control Centre of Excellence, Utrecht:
»Command Post of the Future«, Euskirchen, 03/20/2019

Ndenge, A. F. (Professional Business Solutions -PBS GmbH):
»Algorithm Mining – The Aftermath of Statistics, Data Mining and Artificial Intelligence«, Euskirchen, 04/03/2019

Büttgen, K.-D. (Federal Agency for Technical Relief):
»Forschungs- und Innovationsmanagement im THW«, Euskirchen, 05/08/2019

Walther, C. (Leibniz University Hannover):
»ENTRIA – interdisziplinäre Forschung für die Endlagerung«, Euskirchen, 06/12/2019

Huppertz, G. (Fraunhofer INT):
»Automation, Autonome Fahrzeuge und Künstliche Intelligenz: wie hängt das zusammen und was erwartet uns?«, Euskirchen, 06/26/2019

Wustmans, M. (Friedrich Wilhelm University of Bonn):
»Technologie-Konvergenz«, Euskirchen, 07/10/2019

Köble, T.; Schumann, O. (Fraunhofer INT):
»Proliferationsrisiken neuer Reaktorkonzepte«, Euskirchen, 09/04/2019

Alessi, A. (Fraunhofer INT):
»Studying Silica based materials from bulk to nano-systems«, Euskirchen, 09/11/2019

Eufinger, K. (CENTEXBEL):
»Textil – mehr als ein Stück Stoff«, Euskirchen, 09/18/2019

Kettler, J. (Aachen Institute for Nuclear Training GmbH):
»Aktive Neutroneninterrogationsverfahren zur stofflichen Charakterisierung«, Euskirchen, 10/02/2019

Linde-Frech, I. (Fraunhofer INT):
»Geschäftsfeld Öffentliche Technologie- und Innovationsplanung – Aktuelle Projekte«, Euskirchen, 10/09/2019

Kaluza, B. (Fraunhofer INT):
»Der Wert von Biodiversität – Bienen im Landschaftswandel«, Euskirchen, 10/30/2019

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or Autobahn A61: leave at exit 26 »Swisttal-Heimerzheim«

By air

Nearest airports:

- Cologne/Bonn (60 km)
- Düsseldorf (100 km)

By rail

Nearest Inter-City Main Stations:

Bonn Hauptbahnhof and Cologne Hauptbahnhof.

From there regular rail connections to Euskirchen.

From Euskirchen Station with Bus No 875 in direction

»Großbüllesheim-Wüschheim«; or Bus No 806 in

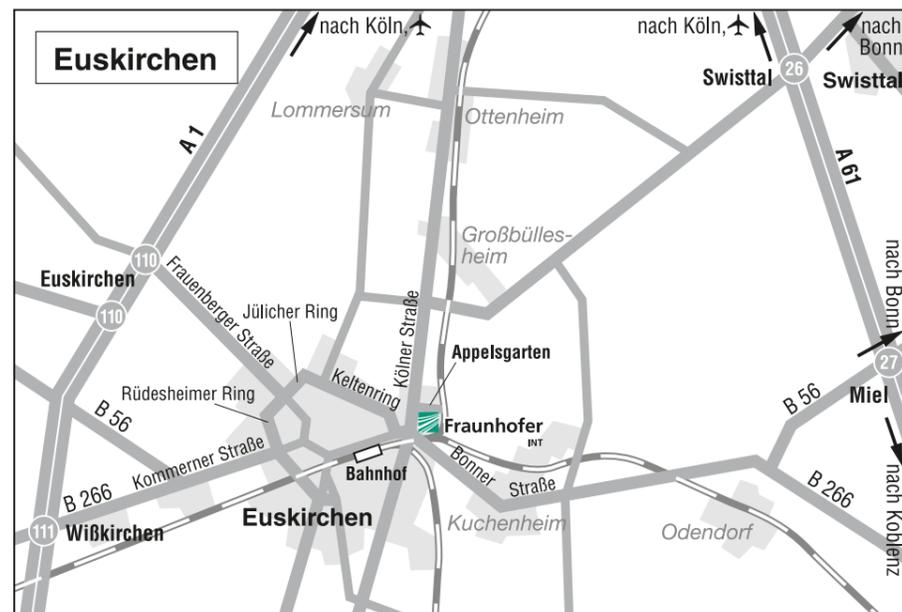
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