Annual report

2020

Fraunhofer Institute for Technological Trend Analysis INT

Foreword

Dear readers,

Who would have thought it?

Something microscopic, which is not even considered a living being, launched a full-scale global attack, brought all of society to a halt and even claimed human life on a large scale.

Was this inconceivable?

Not really. In 2013 (!), Fraunhofer INT published a study entitled “Influenza pandemic in Germany 2020”, which used three scenarios to simulate a similar situation and the ways in which it could be overcome, and made recommendations for action for political and social decision makers.

Amid all the tragedy brought about by these events, this study is an absolute stroke of luck for futurologists: it shows that the scientific methods used can still offer assistance with overcoming the challenges faced in our modern world.

Aside from a bit of self praise for the imagination and foresight of the colleagues involved, we can also say the following:

This pandemic was not at all unthinkable or unpredictable, it was something known as a “wild card” in futurology. We know that such an event can (and will) occur, even if it is uncertain when. Additionally, although the probability of occurrence is relatively low, it will have serious ramifications — which is essentially an obvious hint that we need to be adaptable. The recommendations for action made in the study were rather straightforward and simple, as well as viable, albeit requiring a certain financial cost. They correspond to what was actually implemented with delays throughout 2020.

Even though it is pointless to insist that you know better with the benefit of hindsight, some major research questions immediately present themselves.

In principle, which crises can we prepare for, and which cannot be prepared for? What type of crisis is worth preparing for? (This question is rather delicate when it revolves around human lives and financial and personal costs are offset!) What should the scope of such preparation be?

These questions can be used to quickly arrive at a highly topical subject in relation to the basics of security research. Resilience, a word which is currently on everyone’s lips, is the ability of a system to deal with an external disruption and find its way back to normality in a short amount of time. This is not just a question of defining a couple of terms and making generalisms, it is primarily a question of tangible, multidisciplinary measurement and calculation methods. Can you quantify the resilience of a society? Can the effects that cost-saving measures in the areas of human resources and infrastructure have on the ability of a state to withstand threats be measured? Which investment measures make sense, and which could be excessive? Can we specify universal limits for systems, above and below which resilience is not possible?

Although these questions were not raised as a result of the ongoing pandemic, it has brought these issues to the forefront and highlighted their significance. It is, in fact, a paradox: something microscopic is compelling us to think globally.

One thing is for sure — this crisis will be followed by other crises, and COVID-19 will not be the last of its kind. Whatever the next challenge may be, engaging with our future is ever more important for our businesses, which, as a consequence of being globalized and high-tech, is increasingly vulnerable. Futurology, which is fueled by scientific methods, can provide insight that enables decision makers to make our world safer and more resilient to many threats.

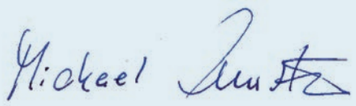
Fraunhofer INT has been active in this area for more than 40 years, dealing with the future challenges of new technologies and security issues. In this way, we are helping to prepare our society for the future.

This annual report contains some of the findings from our research in 2020, the year of the pandemic. As it does every year, it provides an insight into the exciting issues that are keeping the researchers at Euskirchen busy.

Keep testing negative and share our positive view of the future!

I hope you enjoy reading this report,

Sincerely,



Prof. Dr. Dr. Michael Lauster

Content

Profile of Fraunhofer INT

The Fraunhofer Institute for Technological Trend Analysis INT provides scientifically sound judgment and counseling on the entire spectrum of technological developments and considers their interaction with social and economic issues. On this basis, the institute conducts technology-oriented innovation research, which makes long-term strategic research planning possible. Fraunhofer INT draws on this expertise in projects that are tailored to the customer's needs.

In addition to this expertise, the institute conducts its own experimental and theoretical research into the effect of ionizing and electromagnetic radiation on electronic components and systems as well as on radiation detection. For this purpose, the institute is equipped with the latest measurement technology. The main laboratory and large-scale appliances are radiation sources, electromagnetic simulation facilities and detector systems, which are not available in this combination in any other civil facility in Germany.

For over 40 years, the INT has been a reliable partner of the German Federal Ministry of Defense, advising them and conducting research studies in the fields of technology analysis and strategic planning as well as on the effects of radiation. Moreover, the Fraunhofer INT also conducts research for and successfully advises other civil and public clients and companies on a national and international scale, from medium-sized enterprises through to DAX 30 groups.

The business units in this Annual Report

WZA

Defense Technology Foresight

TIP

Public Technology and Innovation Planning

CTF

Corporate Technology Foresight

NSD

Nuclear Security Policy and Detection Techniques

EME

Electromagnetic Effects and Threats

NEO

Nuclear Effects in Electronics and Optics

Organigram

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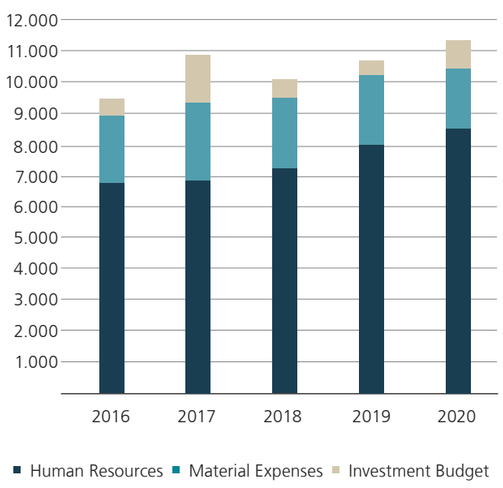
The institute in figures

Despite the particular difficulties of the COVID-19 pandemic, 2020 was a very successful year for Fraunhofer INT. The institute did not record any reductions in project orders — if anything, it witnessed increased demand in some areas of research. The main challenge was conducting work on projects under different framework conditions, in particular with a reduced amount of time spent at the institute. However, this proved very successful due to the dedication of our motivated employees and not least the accomplishments of the central IT department, which laid the foundations for mobile working for all employees on very short notice.

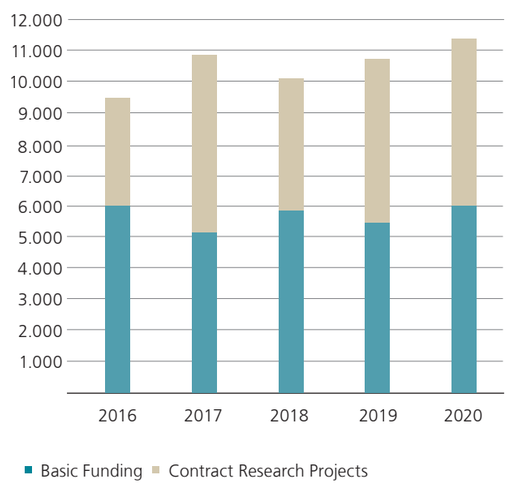
Employees

In 2020, staff capacity at Fraunhofer INT remained stable. By the end of the year, we had employed 125 members of staff with 110.5 FTEs, of whom 64 were scientists (58.9 FTEs). As a result, we cover a wide range of natural and engineering sciences, as well as economic, social and sociological sciences. The researchers are supported by graduate engineers, technicians and administrative professionals. There are also undergraduate and research assistants as well as trainees. Additionally, Fraunhofer INT commands a network of freelance scientists who are regularly involved in the work of the institute.

Budget from 2016-2020



Financial Development from 2016-2020



Budgeted expenditure

The Fraunhofer-Gesellschaft distinguishes between operating expenses and capital expenditure. Operating expenses cover personnel and material expenses, while capital expenditure covers purchases of capital equipment such as scientific and technical equipment for the institute. Operating expenses increased to 10.4 million euros in 2020. In addition, investments amounted to €933,000, resulting in a total budget expenditure of €11.4 million. Additionally, a new experiment hall equipped to investigate electromagnetic effects was largely completed, costing approximately €1.5 million. It was put into operation at the start of 2021. As a result, the institute can considerably expand its experimental capabilities once more.

In addition to base funding from the German Federal Ministry of Defense (BMVg), which has enabled a coordinated research program to be conducted, the institute also receives standard base funding from federal-state funds, which is allocated within the Fraunhofer-Gesellschaft in accordance with performance-based criteria. The Institute generates the remainder of the required funding for the budgeted expenditure by handling a number of contract research projects. In addition to public authorities, project customers include companies from various industries, from medium-sized enterprises to DAX 30 groups, as well as associations and international organizations. For this reason, the share of revenue from projects for the economy has been steadily growing over the past few years. In the public sector, Fraunhofer INT has been providing comprehensive advice to the German Federal Ministry of Defense regarding research and technology planning for the past 40 years. The BMVg is also the biggest client of the research institute in Euskirchen. In addition, research contracts were also carried out for other ministries and official public institutes. EU projects which are conducted alongside partners from a number of European countries also account for a large portion of the revenue.

Employees

	2018		2019		2020	
	Occupied positions	Amount of people	Occupied positions	Amount of people	Occupied positions	Amount of people
Scientists	55.5	59	60.2	65	58.9	64
Graduates	24.0	25	24.0	25	25.0	26
Technicians, other	16.0	18	17.1	19	18.1	20
Assistants, trainees	3.9	7	6.8	14	8.5	15
Total	**99.4**	**109**	**108.1**	**123**	**110.5**	**125**

Budgeted expenditure in € 1,000

Expenses	**2018**	**2019**	**2020**
Operating expenses	9,509.3	10,211.2	10,420.9
of which personnel	7,231.5	7,996.8	8,523.0
of which non-personnel	2,277.8	2,214.4	1,879.9
Capital expenditure	561.9	472.7	933.6
Total	**10,071.2**	**10,683.9**	**11,354.5**
Financing			
Base funding	5,862.3	5,475.5	6,040.5
Contract research	4,208.9	5,208.4	5,314.0

The meeting of the Members of the Advisory Board took place virtually in 2020.

Members of the Advisory Board 2020

The institute is advised by an advisory board, which is composed of leading figures in economics, science, politics and administration.

Chair

Prof. Horst Geschka; Geschka & Partner Unternehmensberatung Innovarium

We are sad to announce that two members of the Advisory Board have unfortunately passed away in the reporting period. Dr. Vera Kamp of Plath GmbH and Dr.-Ing. Thomas Weise of Rheinmetall AG will be missed at the institute on a personal and professional level. Our deepest sympathy goes out to their families and loved ones.

Members

- Udo Becker; Executive Vice President Kreissparkasse Euskirchen
- Klaus Burmeister; foresightlab
- Dr.-Ing. Karsten Deiseroth; IABG mbH
- Prof. Horst Geschka; Geschka & Partner Unternehmensberatung Innovarium
- First Director BAAINBw Rainer Krug; Federal Office of Bundeswehr Equipment, Information Technology and In-Service Support
- Britta Schade; ESA / ESTEC
- Prof. Katharina Seuser; Bonn Rhein-Sieg University of Applied Sciences
- MinR'in Sabine ten Hagen-Knauer; German Federal Ministry of Education and Research (BMBF), Bonn
- Dr. Hans-Ulrich Wiese; former member of the Fraunhofer Executive Board
- Prof. Axel Zweck; VDI Technologiezentrum

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.

75
institutes and research units

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 75 institutes and research institutions. The majority of our 29,000 staff are qualified scientists and engineers who work with an annual research budget of 2.8 billion euros. Of this sum, 2.4 billion euros are generated through contract research. Around two thirds of Fraunhofer's contract research revenue is derived from contracts with industry and publicly funded research projects. The remaining third 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 that 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.

Joseph von Fraunhofer

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.

Figures valid: January 2021
www.fraunhofer.de/en

Frauenhofer Group for Defense and Security VVS

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 benefi ts through mutual support, by complementing one another professionally, through a division of labour and by coordinating the areas in which we specialise.

The Group was founded in 2002 and consist of ten member institutes. It is chaired by Prof. Dr. Jürgen Beyerer, director of the Fraunhofer-Institute of Optronics, System Technologies and Image Exploitation IOSB.

Fraunhofer experts present position paper on the »Rise of Intelligent Systems in Military Weapons Systems«

The capabilities of AI-driven systems have grown markedly in recent years. Artificial intelligence is indeed taking on ever more complex tasks and acting increasingly autonomously, but this technology comes with great responsibility as to how it is handled. Artificial intelligence figures prominently in areas such as manufacturing, logistics planning and medicine, but it may also be deployed in a military context. AI is a topic of debate worldwide, one point of discussion being its role as an enabler of a new generation of autonomous weapon systems. AI-based, autonomous weapon systems will fundamentally change the way armed conflicts are conducted.

Tornado ASSTA 3.1

Evaporation processes in an irradiated sample of carbon fiber-reinforced plastic

This threat situation requires a discriminating assessment of AI deployed in weapon systems. The Fraunhofer Group for Defense and Security VVS has a developed a position paper entitled „Rise of Intelligent Systems in Military Weapon Systems" to this end. This position paper conveys the Fraunhofer VVS's view of the state of the art in this technology, examines its benefits and risks, and presents a conceptual framework for explainable and controllable AI. It identifies and discusses select research topics to point the way towards trustworthy AI and the responsible handling of these systems in the future.

The Fraunhofer VVS's position paper does not provide answers or recommendations as to the military use of artificial intelligence. The aim of the paper is to spark debate about this important future topic and provide fuel for this discussion.

The full paper can be downloaded via www.vvs.fraunhofer.de/en.html

VVS Management

Group Chairman	Prof. Dr.-Ing. Jürgen Beyerer, Fraunhofer IOSB
Group Deputy Chairmans	Prof. Dr. Peter Martini, Fraunhofer FKIE Prof. Dr. Dr. Michael Lauster, Fraunhofer INT
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Coordinator EU Defense	Daniel Hiller, Fraunhofer EMI

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- Fraunhofer Institute for Chemical Technology ICT, Pfinztal
- Fraunhofer Institute for High Frequency Physics and Radar Techniques FHR, Wachtberg
- Fraunhofer Institute for Communication, Information Processing and Ergonomics FKIE, Wachtberg
- Fraunhofer Institute for High-Speed Dynamics, Ernst-Mach-Institut EMI, Freiburg
- Fraunhofer Institute for Technological Trend Analysis INT, Euskirchen
- Fraunhofer Institute for Optronics, System Technologies and Image Exploitation IOSB, Karlsruhe
- Fraunhofer Institute for Integrated Circuits IIS, Erlangen
- Fraunhofer Institute for Experimental Software Engineering IESE, Kaiserslautern
- Fraunhofer Institute for Structural Durability and System Reliability LBF, Darmstadt

Fraunhofer Group for Innovation Research

Opportunities and risks for innovation systems in Germany and Europe

New issues and technologies are appearing on an increasingly frequent basis and pose major challenges to the European and global innovation system, intensified by the COVID-19 pandemic. The pandemic has affected almost all sectors of society and the economy as well as related innovation systems plus, as a result, the ways in which innovations are developed and implemented.

Recognizing the development trends influencing innovation systems and understanding their effects at an early stage is extremely important for the security and the competitiveness of Germany and Europe. On this basis, it is possible to design »future proof« innovation systems that enable the successful development and implementation of innovations. This task, which is anticipatory in nature, must be taken up by players from business, government, science and society.

In 2018, the Fraunhofer Group for Innovation Research used a system analysis to develop five theses for the future of innovation with a view to the year 2030. The theses were put to the test in 2021 in order to evaluate future opportunities and risks for innovations systems in Germany and Europe considering the effects of the COVID-19 pandemic.

Which topics will be influenced by research and development in the future?

To be able to answer this question, the Fraunhofer Group for Innovation Research is currently reviewing the Fraunhofer foresight study published in 2019. The study specifies the key future trends in applied research. The so-called »spotlights« cover various areas and will be brought up to date with respect to the effects of the COVID-19 pandemic by means of the KATI system (KATI: Knowledge Analytics for Technology and Innovation), which was developed by Fraunhofer INT.

The foresight process serves as a broad view to the future. The results form a well-founded knowledge base for a forward-looking approach and numerous points of reference for other projects on specific issues conducted with social, political and public cooperation partners.

Innovation research in times of pandemic

A key challenge for innovation research lies in supporting companies with the implementation of solutions and strategies helping them to overcome crises such as the current pandemic. Here, innovations are the key to making effective decisions and being able to follow the path less traveled in these difficult times, as well as having lasting resilience to crises. Times of crisis provide ample opportunity to think about things differently, assess what has been done up to now and make improvements — put simply, to innovate and to be better prepared for the future. The Fraunhofer Group for Innovation Research makes significant contributions to many areas so that this societal challenge can be overcome. The following is an example of this.

Fraunhofer Group for Innovation Research

Research scenarios as decision-making tools for pandemics

In the »Crisis Management and Resilience — Corona (KResCo)« project, the first step for the segment was to pool its cumulative expertise in innovation. The objective is to produce specific recommendations for action to be taken by decision-makers in the fields of politics, economics, civil protection and research. These recommendations based on scientific evidence should assist with both the current COVID-19 pandemic and any future crises. The results of the project have the capacity to contribute to greater societal resilience. Specific scenarios demonstrate the effects of their respective decisions to those responsible across various fields. Shared understanding and stronger crisis management should arise from this. Another overarching aim of KResCo is to produce readily accessible data sets for further scientific work in relation to pandemics. (For more information on KResCo, please see pages 40/41).

Member institutes

- Fraunhofer Institute for Industrial Engineering IAO, Stuttgart, Germany
- Fraunhofer Institute for Technological Trend Analysis INT, Euskirchen, Germany
- Fraunhofer Institute for Systems and Innovation Research ISI, Karlsruhe, Germany
- Fraunhofer Center for International Management and Knowledge Economy IMW, Leipzig, Germany
- Fraunhofer Information Center for Planning and Building IRB, Stuttgart, Germany
- Fraunhofer Institute for Integrated Circuits IIS, Nuremberg, Germany

More information is available from:

Fraunhofer Group for Innovation Research
http://innovation.fraunhofer.de/en.html
http://s.fhg.de/innovation2030-covid-en
http://s.fhg.de/foresight-fraunhofer-en

Tanja Vartanian, Dr. Sven Schimpf

Business Units

WZA
Defense Technology

TIP
Public Technology and Innovation Planning

CTF
Corporate Technology Foresight

TM
Tools and Methods

NSD
Nuclear Security Policy and Detection Techniques

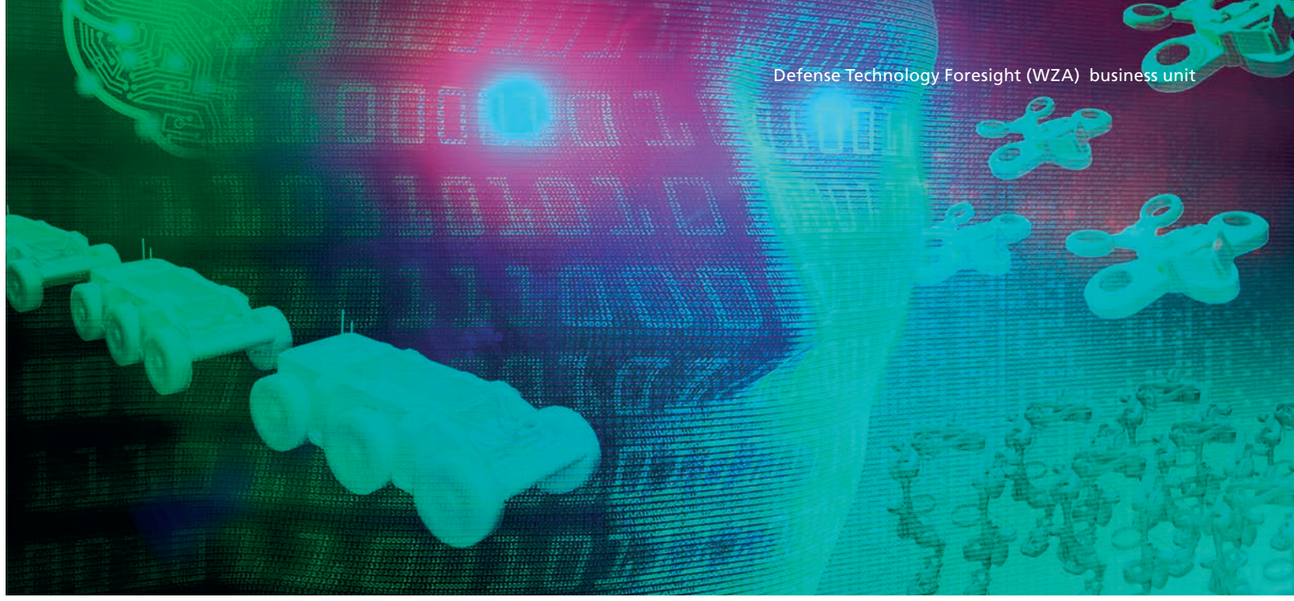
EME
Electromagnetic Effects and Threats

NEO
Nuclear Effects in Electronics and Optics

Scientific-Technical Support

Business Administration and Corporate Services department

Defense Technology Foresight (WZA) business unit



The Defense Technology Foresight business unit conducts long-term, technology-oriented futures research (technology foresight) for public clients in the defense sector. As an institute, it is tasked with operating the technology radar for the German Federal Ministry of Defense (BMVg) and the German Federal Armed Forces (Bundeswehr), and providing evidence-based, technology-oriented decision-making support for their clients' strategical planning processes. Furthermore, WZA is an important information broker for BMVg and Bundeswehr regarding the results of technology-oriented futures research, ensuring a continuous transfer of knowledge to this effect. In addition, it also provides services to international clients such as the European Defence Agency and NATO.

Research focus

Defense-Technologies Forecast for the German Federal Armed Forces (Bundeswehr)

The interdisciplinary futures research of the business unit helps to ensure that clients have reliable orientational and decision-supporting knowledge regarding probable future developments in science and technology and any possible military implications. As a result, WZA contributes to guaranteeing a reliable capability of analysis and assessment of the client in regard to long-term technological developments, their relevance to defense technology and, in this regard, a realistic further development of the German Federal Armed Forces' range of capabilities.

The principal product of the WZA business unit is the Defense-Technologies Forecast (WTV), which is prepared for the German Federal Armed Forces on a quarterly basis. This is an ongoing significant achievement for the business unit, which prepares a total of, annually, 13 WTV analyses and updates on selected technology issues as well as long-term future concepts. Due to the pandemic, only one of the half-yearly client-facing workshops on the respective results and recommendations could be carried out last year. The civil user base of the WTV also saw further development. The German Federal Criminal Police Office (BKA), the German Federal Office of Civil Protection and Disaster Assistance (BBK), Bundesgesellschaft BWI GmbH, the German Federal Institute for Materials Research and Testing (BAM) and now also the Central Office for Information Technology in the Security Sector (ZITiS) receive separate versions of the WTV on behalf of the BMVg. The Royal Netherlands Army also receives the WTV as part of a bilateral agreement with BMVg.

As the principal document used by German Federal Armed Forces for long-term technology foresight, the WTV was once again a significant starting point and source of topics for generating a yearly Situation Picture of the R&T Future for the Research Director of the BMVg. Last year, it was compiled for the third time utilising a wide range of content-related and organizational contributions from the WZA business unit. The aim of the BMVg in this regard is to record, on as broad a scale as possible, all identified long-term technology-driven future issues from the various organizational divisions of the BMVg and Bundeswehr, and to compact them into theSituation Picture of the R&T Future. The third State-of-the-R&T-Future conference was held at the institute on February 12–13, 2020, with almost 90 participants in attendance, and was chaired by BMVg's Research Director (for more on this, see page 48).

Under the ongoing assignment by the Swedish Defense Materiel Administration (FMV), technology briefs on selected topics were produced. In the »Technology Foresight Workshops«, which the European Defence Agency (EDA) has conducted since 2018, WZA staff helped to shape two workshops on »autonomous systems« and »hypervelocity systems« in turn in 2020, taking the roles of moderators and foresight experts. Contributions, most notably the EDA's »High-Power Electromagnetic Munitions (HPEM)« study, HONDA's »Thermal Energy Management Foresight Study« and the ongoing »Crisis Management and Resilience – Corona (KResCo)« internal Fraunhofer study, were made in cooperation with other business units.

The teaching and committee activities of WZA include providing specialist support to the Command and Staff College of the German Federal Armed Forces. For the seventh year in a row, WZA has contributed to the National General/Admiral Staff Officer Course (LGAN), though for the first time they provided two video podcasts for the purposes of online learning due to the pandemic. Furthermore, the programming of a course on »foresight methods« at the University of Applied Sciences Ravensburg-Weingarten was supported by WZA.

The principal product of the WZA business unit is the Defense-Technologies Forecast (WTV), which is prepared for the German Federal Armed Forces on a quarterly basis.

Expert activities for NATO

Since 2016, two scientists from WZA and TIP have been assigned as experts by NATO to their Independent Scientific Evaluation Group (ISEG) for the Science for Peace and Security (SPS) program.

Hans-Martin Pastuszka, Dr. Ulrik Neupert

Public Technology and Innovation Planning (TIP) business unit

Research focus

The business unit mainly focuses on the topic of technology and innovation planning in various application areas, including security research, although other topics are also playing an increasingly significant role.

The business unit Public Technology and Innovation Planning (TIP) organizes the strategic research and innovation planning of public clients, such as European institutions and authorities as well as national public organizations. The services range from consultation about research agendas at a national/European level to strategic planning for capability development at an authority/organization level.

To this end, TIP offers its customers and clients a wide range of innovation and technology management methods:

- Needs assessment and dialog formats with participatory methods
- Screening of possible (future) technological and non-technological solutions
- Analysis of organizational, social and political framework conditions
- Development of research roadmaps for political decision makers
- Preparation of innovation roadmaps for users
- Development of critical success factors and key performance indicators to evaluate new technologies in pilot projects and demonstrations
- Continued development and adaptation of knowledge transfer methods to build cooperation and networks

The security research sector is the main focus of TIP. This is where the business unit, alongside its partner organizations, develops innovative solutions in the international disaster management field and resilience research and creates plans for innovation.

As part of the EU Horizon 2020 **IN-PREP** project (running from 2017 to 2021), TIP is responsible for assessing the end-user needs, evaluating the tests and demonstions of the platform which was to be developed, as well as creating a handbook for cross-border cooperation in the event of a disaster.

Within the Fire & Rescue Innovation Network **FIRE-IN** (EU project, running from 2017 to 2022), TIP provides systematic support to an international network of fire services and first responders in needs assessment and innovation planning.

A new addition to the EU projects in the security research sector is **STRATEGY** (running from 2020 to 2023), which aims at creating a European framework for pre-normative activities in disaster management (see also p. 42).

For the European Directorate-General **(DG) ECHO**, TIP and the consulting firm Ecorys successfully used forest fires as a case study to develop a concept for European **disaster control and management centers (known as "hubs")** (running from 2019 to 2020). The aim of these hubs is to make optimal use of the available knowledge and experience in Europe in the context of disaster risk management.

On a national level, Fraunhofer's internal cross-institute project KResCo, which was launched under the leadership of TIP (running from 2020 to 2021), aims to analyze political decisions in connection with the COVID-19 pandemic and their effects (see also p. 40).

Outside of security research, the German Federal Ministry of Education and Research (BMBF) project "Widening Horizons – Changing Perspectives" (running from 2017–2020), which was tasked with developing strategies for improving the transfer of scientific research to rural areas, was brought to a successful conclusion (see also p. 44).

In addition to this, the Blockchain Reallabor [Blockchain living lab] NRW project (running from 2019–2020) also ended on a successful note in 2020. In this project, a living lab for blockchain applications was constructed in the Rhineland region. p. 46).

Moreover, the Neue Wege der Prävention [New prevention methods] project (running from 2020–2023) of the German Trade Association of the Construction Industry (BG BAU) was launched under the INT-internal leadership of CTF and was involved in developing innovative solutions for minimizing accidents in the construction industry. For this purpose, TIP is in charge of an evaluation concept for assessing the entire project as well as for piloting specific solutions.

The TIP is also devoted to issues outside of security research at EU level. For example, the EU SHAPES project (Smart and Healthy Aging through People Engaging in Supportive Systems) (running from 2019–2023), which has a budget of €18.7 million and 36 partner organizations, is concerned with developing digital solutions for facilitating and prolonging a healthy and independent life for older persons (see also p. 38).

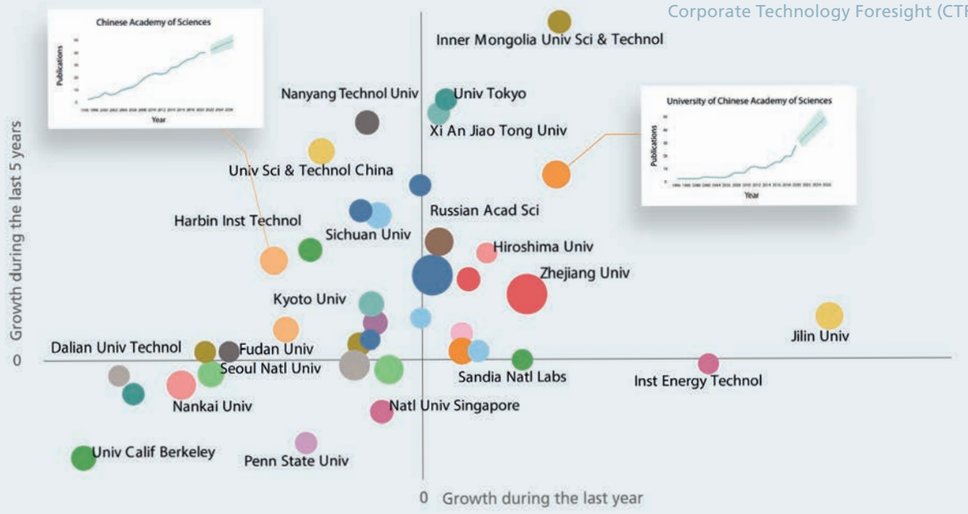
Related to these main activities, TIP also focuses on social issues in the areas of security and new technologies.

*The business unit has also volunteered an expert for the **NATO Science for Peace and Security Program** and represents the **Fraunhofer Segment for Defense and Security (VVS)** at the **Working Group Security and Defense Research** of the **European Association for Research and Technology Organisations (EARTO)**. Since September 2020, Fraunhofer INT has been a member of the **Bonn Network for International Disaster Prevention and Risk Management** through the TIP business unit. TIP is also active in the **Fraunhofer Group for Innovation Research**, the Civil Security Research Innovation Cluster (InCluSiF — Innovationscluster Zivile Sicherheitsforschung) and as a consultant for large research projects.*

Isabelle Linde-Frech

Corporate Technology Foresight (CTF) business unit

Corporate Technology Foresight (CTF) business unit



Depiction of the increase in university publications

The Corporate Technology Foresight (CTF) business unit supports organizations in addressing strategic issues. To this end, the main priority is technology-oriented future and innovation research. In the process of this, we look back on longstanding expert knowledge from the areas of technological foresight and strategic planning.

Businesses which are proactive and want to position themselves so they are resilient in the future need to deal with trends, drivers and the resulting opportunities and risks for their business in a structured manner. In the future technologies sector in particular, looking solely at product technologies is not sufficient — more importantly, a comprehensive view must be taken at the component and system levels as well as of sub-technologies and customer requirements. Only in this way new business model ideas can be generated. Strategic foresight processes based on a specific prediction of the future are insufficient in terms of positioning technology-intensive organizations so that they are resilient when it comes to future uncertainties. The relationships between the most varied technological, societal, economical or political spheres of influence are too complex. As a consequence of this, the flow of information, not only in the scientific community, but also in the media, is growing stronger and stronger. In order to make substantial preparations for the future, a systematic, science-based analysis of the various spheres of influence combined with the comprehensive and structured collection and evaluation of relevant technological information is required.

Method development under the microscope — strategic foresight

Over the past year, two industry studies assessed the potential for quantitative literature reviews to form a possible basis for strategic decisions. To this end, various technology fields in the automotive sector were analyzed by consulting scientific publications and patents in particular. With the assistance of analysis tools such as the KATI support system (KATI: Knowledge Analytics for Technology and Innovation), reports were generated which outlined the previous developments of specific technology fields as well as any possible directions that development may take in the future.

In doing so, it was possible to identify specific patterns in development as well as the main players within particular fields of technology, to describe sub-technologies and to demonstrate the geographic and scientific origin along with the associated publication activity time lags experienced within the technology field. Furthermore, emerging sub-technologies were identified and the Technology Readiness Level (TRL) and future patent activity with regard to technology of various actors were estimated mathematically. Finally, possible courses of action and cooperation partners for customers were illustrated on the basis of these analyses.

Quantitative analyses of the overarching topics of the consortium projects which were funded as part of the innovation program were also carried out as part of the Innopush parallel research project of the Fraunhofer-Gesellschaft. The objectives were to present the productivity levels of the scientific community in this sector, as well as to position the topics addressed with reference to the global and European research environment. For these purposes, the following questions were particularly relevant: How much is being published, and how does this compare to the research landscape on the whole? Where is the range of topics published and which research institutions are participating? Additional and more in-depth analyses of individual key issues addressed in the consortium studies should be performed at a later stage of the project.

Neue Wege der Prävention — NWdP

As part of the „Neue Wege der Prävention" (NWdP) program, the German Trade Association of the Construction Industry (BG BAU) aims to collect ideas and concepts for effective and future-oriented prevention work in order to ensure a decrease in the rate of accidents in their area of responsibility. The program objectives should be achieved by handling the expectations and ideas of customers of BG BAU (occupational safety experts, insured persons, entrepreneurs, private building contractors) and by conducting outside-in research of the construction sector as well as by reviewing and further developing existing offers, products and solutions. In addition to these factors, the image of BG BAU should be improved and their relations with customers optimized.

As part of a syndicate with Berchtold GmbH and Interlutions GmbH, the Fraunhofer INT is acting as a scientific partner organization of the program alongside the BG BAU to offer a partial contribution to a customer-oriented, pioneering and lasting form of prevention. To do this, the Fraunhofer INT is not only tasked with developing an innovative, science-based approach for a systematic foresight process (CTF business unit), but also with developing an innovative, science-based approach for a concept to evaluate the program itself and its individual activities (TIP business unit).

Projects

In order to include other relevant aspects, we cooperate with excellent partners from the field of business or wider society, for example. Customer-specific analyses and technology-oriented research methods can be used to expand the existing short-term perspective (3-5 years) held by many businesses to a long-term perspective (5-20 years). As part of these analyses, future technologies that are relevant to the company can be identified and assessed, attention can be focused on technological "white spots" or complex technology fields and their company-specific implications can be broken down, among other things. As a result, this information may lay the scientific basis for developing long-term technology strategies.

Tools and Methods (TM) group

Tools and Methods (TM) group

Overcoming new challenges with two new groups.

2020 was another successful year for the »Tools and Methods« (TM) group. Alongside their ongoing work on scanning, implementing and further developing the eponymous tools and methods, it was decided that one of TM's main projects, the Knowledge Analytics for Technology and Innovation (KATI) research and analysis tool, would be »spun off«, and TM would be given an additional topic to focus on. This decision was made on the basis of the projects that were successfully conducted and acquired, which suggest that we can expect that KATI will see an increase in commercial use in the near future. Since the end of 2020, the activities surrounding KATI have been continued as part of a new strategic project known as »KATI Lab«. At the same time, TM was renamed into »Technology Foresight and University Hub TFU« and was tasked with systematically strengthening the connection of the Technological Analyses and Strategic Planning (TASP) department to the academic landscape.

Hereafter follow the TM highlights and events of this past year. As always, these activities took place in close consultation with the internal business units of Fraunhofer INT as well as with external customers. This year was unique due to the COVID-19 pandemic, which played a role in many projects and, in all likelihood, will continue to have an effect.

Alongside the TIP and WZA business units, TM is participating in the KResCo (Crisis Management and Resilience — Corona) project of Fraunhofer, which is investigating the decisions and developments of various countries and research organizations throughout the pandemic (see also page 40). Other significant projects in which TM was involved in 2020 were: Foresight Fraunhofer, Fraunhofer Microelectronics Innovation Enhancement (FRAME), the country reports for the WZA business unit and the NATO STO Task Group SAS-123 »Futures Assessed alongside socio-Technical Evolutions«. In these projects, TM provided important methodological and content-related support.

As stated above, 2020 was an important year for KATI. In addition to the development of further data sources, the system continued to evolve. The tool was presented at public events such as the Fraunhofer Solution Days (see page 64) and was utilized in several of the business units' projects. The lessons learned in this process will be vital in the further development of the tool.

TM was able to make significant progress in the second topic of focus, knowledge management, in 2020: The relocation of the »New Technologies« information platform (IPNT) to the internal wiki of the institute began. This was necessary because the old system was not performing at the level required, among other issues. The institute wikis, including the plug-ins used, underwent extensive testing to ensure that they can also be used in the future. Important work has been carried out methodically in the area of patent analysis and patentometry in order to increase the usability of this source for TASP.

There was a series of cooperation with academic institutions. For example, courses were conducted at the Bonn Rhein-Sieg University of Applied Sciences, RWTH Aachen University and the University of Bonn. In addition, TM provided thesis guidance at the Heinrich Heine University of Düsseldorf and Coburg University of Applied Sciences. Another thesis entitled »Spectral Clustering and the Sensitivity of Ellipsoids« of the University of Cologne deserves special recognition. Following his graduation, the master's student continues his work in the form of a doctoral thesis at Fraunhofer INT, in cooperation with the University of Bonn.

A selection of the tools and methods:

- **Bibliometrics/scientometrics**
  Quantitative analyses of scientific information (scientometrics), primarily scientific publications (bibliometrics)
- **Patent analysis**
  Quantitative and content analysis of patent documents
- **KATI assistance system**
  System developed at the INT, for customized analysis and visualization of bibliometric data, among other things.
- **Advanced analytics**
  For advanced analytics, methods such as deep learning and machine learning, neural networks, text and data mining and cluster computing are used; a wide-ranging portfolio of advanced analysis processes that we can utilize and combine in many ways for the purposes of the foresight process.
- **Knowledge management**
  Knowledge management describes the deliberate and systematic handling of knowledge resources and the targeted use of knowledge. This encompasses the entirety of the concepts, strategies and methods that facilitate »learning« in the figurative sense at the organizational level and support the application of (practical) knowledge and skills. The collection, selection, storage, expansion, replacement/updating of knowledge and knowledge transfer all count as examples of knowledge management.

Nuclear Security Policy and Detection Techniques (NSD) business unit

Nuclear Security Policy and Detection Techniques (NSD) business unit

Source holder of the dynamic qualification test system for radiation gages

QuTeSt

Qualification Test System for Radiation Detection Devices (results of statistical tests on page 58)

The Nuclear Security Policy and Detection Techniques (NSD) business unit carries out theoretical and experimental research and development in regard to nuclear security policy and detection techniques. In addition to fundamental research on that topic, the business unit also works on research projects for industrial and public clients. Furthermore, they are developing and consolidating the national judgment on the field of nuclear and radiological weapons and the asymmetric threats involved.

A high-performance Linux cluster is used to simulate physical processes. Besides coupled neutron and gamma transport calculations, coupled neutron transport and hydrodynamic calculations are also performed. Several neutron generators (14 MeV and 2.5 MeV) and isotope laboratories are operated for experimental investigations. A number of different devices for measuring radioactive radiation, especially those used for on-site measurements, are available for tests and comparisons. The Qualification Test System for Radiation Detection Devices (QuTeSt) is also available for static and dynamic testing of radiation measurement systems according to relevant standards.

In the nuclear disarmament and proliferation sector, political and, most notably, technological developments are continuously monitored from a physical-technical point of view. In this context, the business unit cooperates with ESARDA (European Safeguards Research and Development Association) and INMM (Institute of Nuclear Materials Management), takes part in the technical preparations for the Comprehensive Nuclear-Test-Ban Treaty (CTBT) and is a partner in international CBRN(E) projects.

In the »Quantitative analysis of toxic and non-toxic materials« (QUANTOM) research project, which was requested by the BMBF as part of the »FORKA — Research for the decommissioning of nuclear facilities« grant initiative, the business unit, alongside the companies Aachen Institute for Nuclear Training GmbH (AiNT) and Framatome GmbH, is developing a waste package measurement system for assessing the material contained in radioactive waste packages for the Konrad final repository. Prompt and Delayed Gamma Neutron Activation Analysis (P&DGNAA) is applied as an innovative analysis technique. Fraunhofer INT developes the neutron flux measurement system around the waste package and determines the neutron field outside of the system to support the system's radiation protection design simulation. The waste package measurement system is a significant contribution in terms of qualifying radioactive waste at a low cost and massively reducing the amount of radiation that operating personnel are exposed to.

At the close of the ITRAP+10 Phase 2 project of the EU DG Home, the project's results were presented as part of a side event at the IAEA (International Atomic Energy Agency) »International Conference on Nuclear Security: Sustaining and Strengthening Efforts« conference. With the project's support, reference laboratories were constructed in five EU countries for the purposes of qualifying radiation detection devices to prevent the illegal transport of radioactive and nuclear materials; one such laboratory was implemented at Fraunhofer INT. A measurement system for static measurements as well as one for dynamic measurements were developed and constructed, and surveyed as part of a round robin test with the other reference laboratories. The Fraunhofer INT-developed QuTeSt testing system, with its testing mechanisms for qualifying nuclear and radioactive material detection devices, was also presented in detail at the conference by means of a poster.

Investigations were continued into the use of alternative materials for neutron detection. In order to construct detectors more compactly when using such alternative materials, the use of silicon photomultipliers (SiPM) to detect single photons with the aid of silicon avalanche diodes was investigated. As these SiPMs are also lighter than conventional photomultipliers, they can also be used to construct systems with less weigh.

In addition to examining detector systems with new detection materials, basic studies were also conducted as part of a doctoral thesis.

At the INMM (Institute of Nuclear Materials Management) annual conference, which was held virtually this year, the business unit held a talk on qualification measurements for the civil protection applications of handheld radiation detection devices. The ESARDA annual conference also took place virtually this year, with employees from the business unit participating in the Verification Methods and Technologies (VTM) working group and the Non-destructive Assays (NDA) working group.

The business unit continued to participate in standardization activities for radiation detectors; in the DIN/VDE in Germany and internationally in the appropriate IEC committee. In the process, the conventions on illicit trafficking of radioactive materials, which specify the requirements for radiation detection systems at border crossings and similar checkpoints, are dealt with.

Competencies

By combining the assessment of technical issues regarding nuclear security policies and the continued development of nuclear detection processes, the business unit is not only able to act competently on associated issues in international organizations, but also to examine specific questions posed to national authorities and companies in regard to protection against nuclear hazards.

Dr. Theo Köble

Electromagnetic Effects and Threats (EME) business unit

Open three-strip TEM waveguide

Equipment (VG) standard groups on NEMP and lightning protection and electromagnetic compatibility as well as participation in the IEC Joint Working Group Reverberation Chamber as the national representative, and the advancement of HPEM standardization with the goal of producing a NATO HPEM protection guide.

The Electromagnetic Effects and Threats (EME) business unit is tasked with contributing to creating the ability to provide judgment in the field of electromagnetic effects in regard to military threats, using a portion of the base funding from the German Federal Ministry of Defense (BMVg). As this task is only carried out to a certain extent at the German Federal Ministry of Defense (BMVg), the business unit conducts its own theoretical and experimental research, including the continued development of measurement technology, in consultation with the authorities and in collaboration with companies in the defense sector. Beyond the research and contract research projects for the BMVg which are receiving base funding, work for clients outside of the defense sector (civil security research) and industry projects is also of significance.

The business unit's experimental work on electromagnetic threats, caused in particular by high-power microwaves (HPM), includes studies on electromagnetic field coupling in structures and specific systems as well as the vulnerability of electronics to high-intensity fields (high power electromagnetics, HPEM). The test objects range from IT devices and systems based on current IT technology and, in particular, wired and wireless data transfer technology (network engineering), to civil communication technology and components of critical infrastructures. Furthermore, basic investigations and experimental work are continued on methods for detecting electromagnetic threats, in particular from HPM.

The business unit has access to a TEM (transverse electromagnetic mode) waveguide, developed in-house, which is located in a shielded hall for frequencies up to several gigahertz. Using this equipment, linear coupling measurements for determining transfer functions and investigations on electromagnetic compatibility (EMC) can be carried out at a wide range of frequencies. Moreover, studies into the susceptibility of objects measuring up to several meters in size can be conducted using constant and pulsed fields with field strengths measuring up to several kilovolts per meter (kV/m). For measurement tasks outside of the institute, the business unit uses a mobile HPM irradiation facility, which was also developed in-house. This system can also generate field strengths of several kilovolts per meter (kV/m) at a wide range of frequencies using various antennas for irradiation. These systems are complemented by a reverberation chamber equipped with high-power sources for generating even higher field strengths in the gigahertz range in order to account for the growing range of modern sensor and communications technology applications at these frequencies. In addition, the business unit operates a small anechoic room and a large assortment of radio frequency and microwave technology. A construction project for an anechoic chamber, which was partially funded by the Central Strategy Fund of the Fraunhofer-Gesellschaft, was largely completed, constituting a new test environment for the business unit (see also report from page 44).

As part of the research for the BMVg, a project was completed in 2020 on HPEM detector development and on investigations of generation dependence of the HPEM vulnerability of electronics, which was commissioned by the Bundeswehr Research Institute for Protective Technologies and CBRN Protection (WIS) in Munster, Germany. In a follow-up project, work was continued on the HPEM susceptibility of sensors and studies were started on HPEM effects and information security. Results were presented at the EMC Europe 2020 virtual conference. For the latter topic, the business unit supervises also a doctorate in »IEMI and Information Security«. The cooperation with the Swedish Defense Research Agency (FOI) was continued in 2020 within the framework of a technical agreement entitled »Development of High-Power Microwave Test Methodology and Procedures«. A reference test setup for these investigations was described in greater detail at the virtual emv digital and EMC Europe 2020 conferences as well as in a publication in IEEE Letters on Electromagnetic Compatibility Practice and Applications. Likewise, a project was continued on UAS HPEM susceptibility studies for counter-UAS effectors, which was commissioned by the Bundeswehr Technical Center for Information Technology and Electronics (WTD 81). The results were published for the AFCEA trade exhibition »Digitalization in practice — MEANS — IMPACT — CONSEQUENCES«.

Furthermore, starting in 2020 the EME business unit collaborated with the WZA business unit at Fraunhofer INT and Fraunhofer EMI on an EDA project entitled: »High Power Electromagnetic Munitions (HPEM)«. In 2020, a doctorate on the topic of »EMI Risk Management on the scale of the Smart Grid as a network of systems« began as part of the Marie Curie ETN »Pan-European Training, Research and Education Network on Electromagnetic Risk Management — PETER« EU project, of which the business unit is one of 19 project partners. Within the Fraunhofer Young Research Class 2019 program on the topic of »Resilience of Critical Infrastructures« a junior scientist from the business unit participated in the project »SMARTKRIT — Smart, adaptive energy management in the case of crises using existing autonomous transport system fleets«.

Doctorate »Vulnerability of the smart grid to HPEM«

Finally, a doctorate on the topic of »Vulnerability of the smart grid to HPEM« was concluded within the business unit last year and the results were published in IEEE Transactions on Electromagnetic Compatibility.

Nuclear Effects in Electronics and Optics (NEO) business unit

In 2020, two significant strategic topics were made the focus of further research: the ongoing investigation of single event effects (SEEs) and the investigation of radiation effects on commercial off-the-shelf (COTS) electronic components.

The Nuclear Effects in Electronics and Optics (NEO) business unit specializes in the effects of ionizing radiation on electronic, opto-electronic and optical components and systems. NEO performs these irradiation tests based on internationally recognized standards and advises companies regarding radiation qualification and hardening, for example, for satellites or accelerators. Furthermore, the knowledge obtained is also used for the development of radiation sensors. Fraunhofer INT performs irradiation tests primarily at its own irradiation facilities; however, it also has access to external facilities. Its irradiation facilities are unique in Europe and allow all relevant types of radiation for satellites, for example, and the effects induced by these to be recreated in the laboratory. In addition, the business unit has access to state-of-the-art measurement technology in order to measure even the smallest changes to characteristic parameters.

In addition to the RACOCO project contract awarded to Fraunhofer INT by the European Space Agency (ESA) in 2019, the proportion of COTS components investigated has also increased significantly in other projects. While these components previously only accounted for around 10% of studies, this figure increased dramatically in 2020 to approximately 50%. This clearly shows the trend towards cheap and volume-based manufacture of aerospace products.

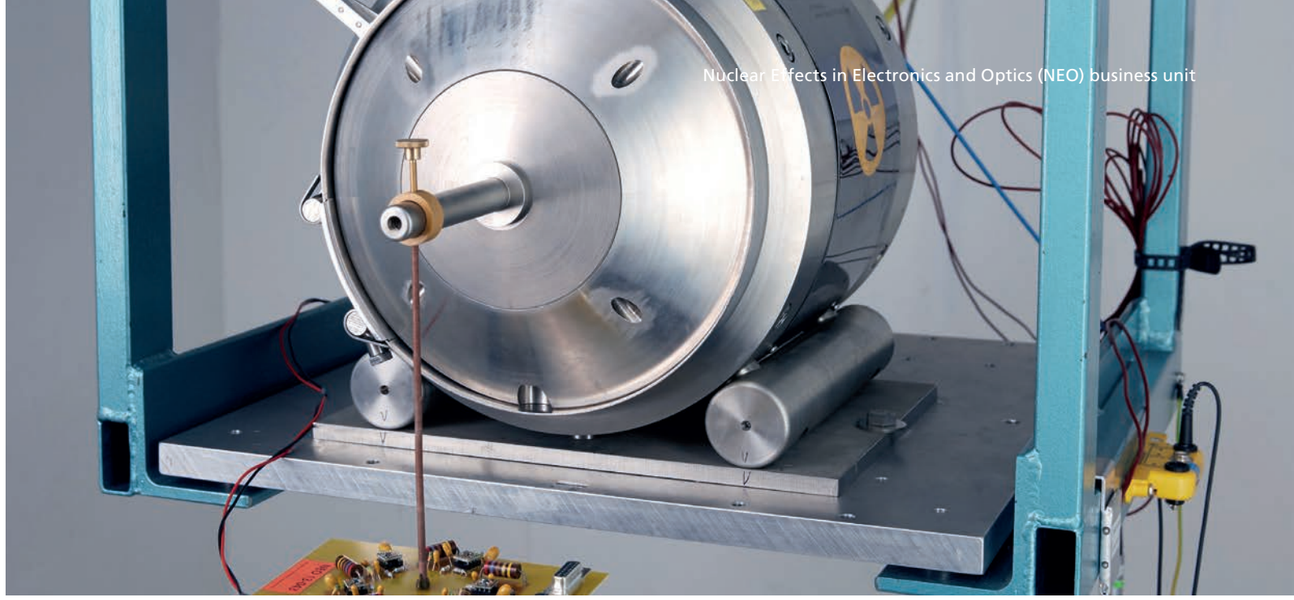
This development requires the use of efficient test methods that can also work on a larger number of samples because a broader statistical basis is needed due to the expected greater variation in characteristics.

As a result of the pandemic, there were significant restrictions affecting the implementation of external campaigns; however, even tests conducted by external project partners at NEO irradiation facilities required new approaches. The possibility of implementing campaigns via remote access without a physical presence at the INT was therefore significantly extended. Overall, despite the pandemic, more projects were successfully completed in 2020 than in previous years.

Moreover, Fraunhofer INT was awarded a support contract by the EEE group at the Space Travel Management department of the German Aerospace Center (DLR) — a significant achievement. As part of this agreement, NEO employees will provide the German Aerospace Center with support over the next three years for all issues relating to radiation effects, whether that be in the implementation of projects, technical consultation, or representation in national and international committees.

A student successfully completed their master's thesis in cooperation with the University of Applied Sciences Jena. As the subject of the master's thesis will be used in ongoing projects, the graduate was offered permanent employment and has since then strengthened the team at NEO.

Lastly, the business unit presented at several virtual events and published contributions in international peer-reviewed journals. NEO not only contributed with invited lectures but was also involved in the organization of the conference.



Nuclear Effects in Electronics and Optics (NEO) business unit

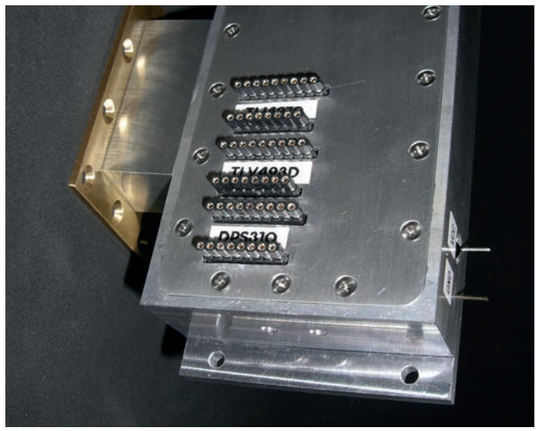
The business unit uses a large number of different irradiation facilities for its tests:

- Three Co-60 gamma irradiation facilities (point geometry; dose rate: 10 µGy/s to 2 Gy/s)
- Two neutron generators (energy: 2.5 and 14 MeV; neutron flux: up to 3·1010 n/s in 4π)
- 450 keV X-ray facility
- One laser for SEE tests (wavelength: 1064 nm; pulse duration: 9 ps; energy: up to 200 µJ/pulse)
- One exclusive proton irradiation beam line at the Jülich Research Center (energy: 39MeV to 2 GeV)
- Possibility for Co-60 high-dose irradiations (MGy)

Scientific and Technical Support (STS)

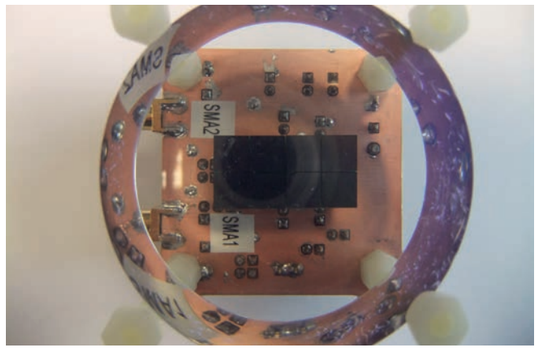
The Nuclear and Electromagnetic Effects (NE) department has a comprehensive scientific and technical infrastructure, which supports experimental work in the following three business units: Nuclear Security Policy and Detection Techniques (NSD), Nuclear Effects in Electronics and Optics (NEO) and Electromagnetic Effects and Threats (EME). The Scientific and Technical Support (WTI) division is equipped with a precision engineering workshop in which special mechanical parts are manufactured for the experimental facilities as well as an electronics workshop that manufactures special electronic components and that carries out maintenance and repairs for experimental electronics.

Mechanical workshop



As part of a doctoral thesis supervised by the EME business unit, research was conducted to investigate how sensitive selected sensors are to high-power electromagnetics (HPEM). The evaluation electronics needed to be protected from the affects of the radiation and therefore had to be housed inside effective protective casing. To that end, the precision engineering workshop worked to improve the shielding effectiveness of the casing that was purchased, drilled holes for line filters and fiber optic components, cut slits for IC sockets in the cover and primed the inside of the casing in order to install the self-built PCB.

Electronics workshop



View through the crystal of 2x quadrant detector

For one customer, the NSD business unit developed a compact radiation detection system for gamma and neutron radiation. A provisional design for this was developed in the electronics workshop. The image shows the view through a crystal in which photons are generated by radiation. These are converted into electrical signals by photosensitive avalanche photodiodes (the black squares in the center of the image). The PCB shown here from the underside allows these signals to be decoupled for external analysis and enables the effect of interconnecting the detectors to be investigated. Due to photosensitivity, this experimental setup can only be investigated in light-proof casing.

The Secretariat supports the NE department as follows:

- provides organizational support for projects
- helps generate reports for experimental tests
- assists in radiation protection matters
- participates in the preparation and implementation of workshops
- creates questionnaires (also online).

Peter Clemens

Business Administration and Corporate Services department

The Business Administration and Corporate Services department performs all commercial and administrative tasks, and provides the main infrastructure for the institute.

The department is divided into the following subgroups: Finance, Human Resources and Legal Affairs (FPR), Marketing and PR (MPR), and Central Infrastructure Services (ZI). There is also the independent division, Library and Specialized Information Services.

The **Finance, Human Resources and Legal Affairs** group is responsible for procurement, bookkeeping, accounting, controlling, human resources, travel management and event management. Over the past year, the commercial processes were evaluated, improved and documented with a view to introducing a quality management system.

The **Central Infrastructure Services** group handles facility management/internal services and central IT services. Facility management continues to play a key role in coordinating the various construction projects on site at the institute. The Central IT Services (zIT) division is in charge of the entire IT infrastructure at the institute. It provides first level support for users.

At the beginning of the first lockdown in March 2020, the zIT division was faced with the technical challenge of ensuring that the entire workforce at the institute could work from home. Fortunately, in 2019 the institute decided to facilitate and strengthen remote working as part of its strategy process and this proved to be extremely helpful. The measures required to implement this had already been introduced in the autumn of 2019, including ordering and provisioning numerous notebooks. The project to enable remote working was originally scheduled to be completed at a significantly later date and the complete rollout of hardware at the institute was not due to take place until well after the first quarter of 2020. The fact that the division succeeded in completing the project well ahead of schedule — despite supply bottlenecks affecting hardware availability caused by a disruption to the supply chain brought about by the early lockdown in China and, of course, the explosion in demand for mobile working devices throughout the pandemic — can be attributed to impressive improvisational skills and a lot of overtime.

The **Marketing and PR** division is responsible for implementing all central measures to communicate and promote the work results of the different business units at the institute. This includes, inter alia, traditional PR work, online communications and social media, drafting and preparing brochures and information materials as well as organizing appearances at trade shows and conferences. Due to the COVID-19 pandemic, almost all specialist and industrial trade shows were canceled in the year under review, which is why the business unit concentrated on the development and execution of concepts in order to participate in digital trade show formats.

The **Library and Specialized Information Services** division primarily focuses on procuring and managing the media required for the scientists' work at the institute and supporting them to acquire references and other information. Depending on a project's requirements, licenses for additional specialist databases and other sources of information are obtained and issued. In addition, project participants receive advice and support in the context of their publishing activities to implement new requirements issued by public sponsors. The Library and Specialized Information Services division is the INT contact in the area of research data management for the new joint project »KResCo«. There is a separate work package for this in the project.

Prof. Dr. Harald Wirtz

Research Highlight-Reports

SHAPES — Smart and Healthy Aging through People Engaging in Supportive Systems

SHAPES — Smart and Healthy Aging through People Engaging in Supportive Systems

The EU project »SHAPES« (Smart and Healthy Aging through People Engaging in Supportive Systems, https://shapes2020.eu/), launched in November 2019, aims to develop a technology platform that integrates both a variety of digital solutions — for example from the fields of robotics, virtual chatbots, artificial intelligence and video communication tools — and numerous sensors from the field of health and smart homes to facilitate long-term healthy and active aging and the maintenance of a high-quality standard of life in the increasing aging population.

When it became apparent how severely the COVID-19 pandemic had impacted the European healthcare system, the EU Commission asked SHAPES management to adapt the project in such a way that the digital technologies (further) developed as part of the project could be used as solutions to pandemics and the resulting challenges.

SHAPES focuses on support, care and rehabilitation in the home environment and therefore many SHAPES technologies are designed to facilitate remote medical care for older persons so that they do not need to visit a doctor or hospital. In the event of any future local or national lockdown, older persons with chronic diseases will now receive better care and be more closely monitored.

Another strength of the SHAPES project will be risk prevention and risk monitoring of older persons. The original idea was to use artificial intelligence to monitor heart patients or persons with diabetes, for example, and warn them when their various health parameters indicate that they are at risk. Over the past few weeks, however, the technical partner organizations have focused on developing additional products that can be used for risk monitoring and identification specifically in the context of the current COVID-19 pandemic.

A total of 25 European partner organizations are working on this ambitious innovation project under the supervision of Maynooth University in Ireland. The project will receive funding from the EU Commission, amounting to 18 million euros over a period of four years.

One of the tasks that Fraunhofer INT has is to head the pilot campaign in which the SHAPES platform and its digital solutions will be tested and evaluated at 15 different pilot sites across Europe. Around 450 older persons will take part in this pilot test, either in their own home environment or in nursing homes, as well as many relatives, carers and medical professionals.

Moreover, the catalog of requirements for the SHAPES platform will also be created at Fraunhofer INT, which will be developed on the basis of extensive literature research and interviews. The Foresight group at Fraunhofer INT will also carry out regular foresight activities with the aim of continuously integrating future technologies and future social developments into the project. During a virtual workshop held on May 12, 2020 (https://shapes2020.eu/workshop-1/), participating experts had the chance to discuss their views on future requirements and technological solutions, and to include these in the process.

This project was funded by the Horizon 2020 research and innovation program of the European Union under grant agreement no. 857159.

Dr. Sonja Grigoleit, Simone Schmitz

»Fraunhofer vs. Corona«: Start of Fraunhofer KResCo joint project

»Fraunhofer vs. Corona«: Start of Fraunhofer KResCo joint project

ZIn collaboration with the other institutes belonging to the Fraunhofer Group for Innovation Research, Fraunhofer INT started to work on the project »KResCo« (Crisis Management and Resilience — Corona) in November 2020. The objective of the KResCo project is to analyze political decisions and their impact in relation to the COVID-19 pandemic. Using this basis, recommendations for action are to be developed for various areas of society, with the aim of providing guidance during this and for possible future pandemics.

The project aims to produce specific recommendations for action to be taken by decision-makers in the fields of politics, economics, civil protection and research. These recommendations based on scientific evidence are intended to assist with both the current COVID-19 pandemic and any future challenges. The results of the project have the capacity to contribute to greater societal resilience as decision-makers will have a better understanding of the ramifications of their decisions and crisis management should be strengthened as a consequence.

Another overarching aim of KResCo is to produce readily accessible data sets for further scientific work in to the field of pandemics.

As part of the project, political decisions made by various countries in relation to the COVID-19 crisis will be used as the central starting point. In the first step, empirical data was obtained and collected. Then, the effects of political decisions were analyzed in terms of four social systems and their stakeholders. The research areas are the economy and society, innovation, civil protection and emergency response, and research.

Over the course of the project, decisions and developments in Germany during the pandemic will be compared with those of other European and non-European countries. In addition to Germany, Austria, Italy and Sweden are among the four core countries that will be comprehensively analyzed. Italy, which was the first European country to record COVID-19 cases, and Sweden, which opted for a herd immunity approach, provide interesting comparison options.

Under the coordination of Fraunhofer INT, Fraunhofer IAO, IMW, IRB and ISI will all work on the project. The Public Technology and Innovation Planning (TIP) business unit is working thematically on the work package »civil protection and emergency response«. The Defense Technology Foresight (WZA) business unit and the Technology Foresight and University Hub group are involved in the work package »applied research«. This work package investigates the risk management strategies of applied research institutes, particularly research and technology organizations (RTOs), specifically in the context of the COVID-19 pandemic. It is one aim to make the research data sets generated and used in the project available to the public for further use. To facilitate this and enable the scientists working on the project to adequately deal with all the research data, a standardised process will be established for the work package »research data management«. This will be supported by the data managers at Fraunhofer INT.

Participating institutes:

- Fraunhofer Institute for Industrial Engineering IAO, Stuttgart, Germany
- Fraunhofer Information Center for Planning and Building IRB, Stuttgart, Germany
- Fraunhofer Institute for Systems and Innovation Research ISI, Karlsruhe, Germany
- Fraunhofer Center for International Management and Knowledge Economy IMW, Leipzig, Germany
- Fraunhofer Institute for Technological Trend Analysis INT, Euskirchen, Germany

EU project »STRATEGY«: effective Pan-European crisis management

EU project »STRATEGY«: effective Pan-European crisis management

Managing crises for example caused by natural disasters, industrial accidents or terrorist attacks, requires the cooperation of a number of organizations, all of which generally have different structures, operational procedures, terms, concepts or technical tools. In addition, when crisis management extends beyond national borders, there are different regulatory frameworks to consider, along with language barriers. These differences hamper efficient cooperation during a crisis.

This is where the EU project »STRATEGY« (Facilitating EU pre-Standardization process Through stReamlining and vAlidating inTeroperability in systems and procedures involved in the crisis manaGement cYcle) comes into play: The aim of STRATEGY is to improve resilience in the EU to different types of disasters by strengthening the interoperability of systems and operational procedures in Pan-European crisis management. Standardization processes across Europe play a key role in this. For this reason, STRATEGY brings together 23 partners from 14 EU Member States — including companies, RTOs (such as Fraunhofer), user organizations (such as fire departments, rescue services, police) and national standardization bodies from five different countries — to build a Pan-European structure for pre-standardization activities. The project was launched in September 2020 and will run for a period of three years.

Based on previous analyses, including from EU projects such as ResiStand, in which Fraunhofer INT was also heavily involved, STRATEGY addresses eight topic fields: search and rescue, critical infrastructure protection, response planning, command and control, early warning, training, terminology, and — as a special hazard type — threats from CBRNe (chemical, biological, radiological, nuclear and high yield explosives). In doing so, initiatives of the European Defense Agency (EDA) in the field of CBRNe should also be supported.

Standards that already exist as well as those under development and potential new ones will be selected, tested, adjusted where necessary and then implemented. To that end, technical equipment, systems or processes that could be established as standard will be incorporated into use cases (i. e., in specific contexts in which they are to be used). The different planned standards will then be tested and evaluated in several simulated tabletop exercises as well as a full-scale exercise. Over the course of the project, the project partners will actively participate in all stages of a standardization process, from pre-normative activities through to specific standardization work.

Fraunhofer INT is collaborating on STRATEGY across departments. The Public Technology and Innovation Planning (TIP) business unit is heading up the project's largest work package in which scenarios, use cases, etc. will be defined and simulated tabletop exercises will be performed. In addition, TIP is coordinating work in the area of terminology, as well as political and organizational framework conditions, and is organizing the evaluation of potential standardization topics, final recommendations and a roadmap for future standards in crisis management. The Nuclear Security Policy and Detection Techniques (NSD) business unit is contributing its expertise in the field of radioactive and nuclear threats to activities with respect to the CBRNe threat type.

This project was funded by the Horizon 2020 research and innovation program of the European Union under grant agreement no. 857159.

Maike Vollmer

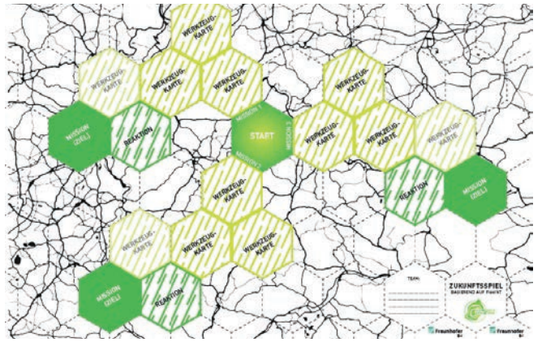
Successful conclusion of the BMBF project »Expanding Horizons«

A stop on the future "tour".

Successful conclusion of the BMBF project »Expanding Horizons«

In the autumn of 2020, the project »Expanding Horizons« funded by the German Federal Ministry of Education and Research (BMBF) came to a successful conclusion. As part of the project, Fraunhofer INT was responsible for identifying customized technologies for rural areas in Germany and for developing a social gaming format to determine technological needs (see playing field). Under the supervision of Fraunhofer CeRRI, the project was carried out in cooperation with the Humboldt University of Berlin, the Institute for Social Innovation (ISInova) and the Leibniz Institute for Regional Geography (IfL). The overarching aim was to improve the technology transfer between urban and rural regions, and to strategically position rural areas as drivers of innovation.

In the project, the work package Technology foresight aimed to identify the most suitable technologies to meet the needs of rural areas for the time horizon 2034. To that end, the project integrated a variety of perspectives and expertise through a combination of different methods (quantitative research, qualitative guided interviews, gaming, workshops, quantitative assessments, written surveys using weighted-bit



Playing field for the future game.

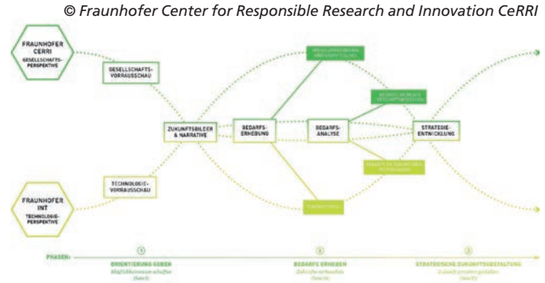
assessment tables). The end result were 15 key technologies that can facilitate the future visions of residents in rural areas. Along with the identified technologies, research needs and structural modifications were also identified and addressed in the form of derived recommendations.

In addition to identifying key technologies, the project also developed a new foresight method that equally combines

Adaptive Elemente
Big Data
Blockchain
Cloud Computing
Internet of Things
Cloud Manufacturing
Virtual Reality
Soft Robotics
Printed Electronics
Additive Fertigungstechnologien
Smart Materials
Autonomes Fahren
IT-Plattform
Künstliche Intelligenz
5 G

Key technologies which should facilitate the future visions of residents of rural areas.

technology and society foresight in new ways. This was successfully applied in three model regions. The newly developed gaming method was very important for the involvement of residents in providing perspectives. Overall a combination of design research methods alongside empirical methods and a social gaming format were integrated. Not only did the project identify technologies and this new methodology, but it also produced several helpful publications, for example, »Horizonte Erweitern — DIE BOX [Expanding Horizons — THE BOX]« (https://www.cerri.iao.fraunhofer.de/de/news-uebersicht/horizonte-erweitern-box.html), a strategy tool for regional developers; a brochure on the aforementioned new foresight methods (https://www.cerri.iao.fraunhofer.de/de/publikationen/h-2.html); and a master brochure documenting all of the project's results (https://www.int.fraunhofer.de/de/geschaeftsfelder/oeffentliche-technologie-und-innovationsplanung/Projekte/projekte.html#horizonte). A session on Green Week in Berlin was also organized, which was well attended.



The process model: the double helix

Blockchain living lab in the Rhineland region

Blockchain living lab in the Rhineland region

The project »Blockchain Reallabor im Rheinischen Revier [Blockchain living lab in the Rhineland region]«, which ran from September 2019 to December 2020, worked on developing functional and practical applications to exploit the potential of blockchain technology, focusing particularly on sectors that are prevalent in the Rhineland region (energy, production, logistics, finance and insurance) as well as public service uses. These use cases will provide the basis for the creation of a blockchain living lab in the Rhineland region, with the aim of implementing network-based cooperation in the area and beyond. The project involved players with experience in science, economics and start-ups, from the Rhineland region and beyond, and utilized their expertise to ascertain the research questions and framework conditions required for this and to identify the most promising use cases and courses of action for the living lab.

Blockchains are the modern equivalent of ledgers. These are now predominantly digitalized and form the backbone of our economy along with the fundamentals of accounting. Distributed ledgers (distributed ledger technology — DLT), a well-known variant of which is blockchain, perform the same tasks as traditional ledgers in principle. In their simplest form, these are decentralized databases that can be managed and updated by any participant in a large network. Blockchain's distributed architecture facilitates a new way of storing, processing and using data, which goes beyond using simple databases. This provides new opportunities to expand cooperation networks and organizational structures, for example those of companies, authorities and administrators. In addition, new types of relationships can be formalized and secured in the digital world so that, for example, the costs incurred for ensuring confidence (previously borne by notaries, lawyers, banks, supervisory authorities, governments, etc.) can be avoided through the relatively fraud-proof architecture of distributed ledgers. To be able to use DLT securely and reliably in the long term, key aspects of cybersecurity must be considered in its implementation.

As part of this project, Fraunhofer INT analyzed key framework conditions for establishing the living lab and produced recommendations for action. A detailed technology analysis was undertaken and an inventory and needs assessment for DLT in North Rhine-Westphalia was carried out, whereby players and use cases, among other things, were identified based on the current and future potential of blockchain technology. The involvement of stakeholders in the development of the living lab was also supported using participatory methods.

These methods included interviews, online surveys, various workshop formats such as world cafés, as well as the implementation of an interaction format for the final event in December 2020. Due to the COVID-19 pandemic, this event had to take place as a hybrid event. Nevertheless, participants interacted well via digital means and were asked their views and assessments.

Over the course of the project, Fraunhofer INT laid the essential foundation for the project and the further development of the blockchain living lab. Preparation for actually establishing the blockchain living lab is currently underway.

3rd Conference on the State of the R&T Future on Fraunhofer INT premises

3rd Conference on the State of the R&T Future on Fraunhofer INT premises

»This conference provides players with a crucial, comprehensive platform to network and exchange views on technology-related future issues of potential relevance for the German Federal Armed Forces.«

Ralf Schnurr,
BMVg Research Director

3rd Conference on the State of the R&T Future on Fraunhofer INT premises

Future technologies and their possible relevance to the German Federal Armed Forces (Bundeswehr) are considered and analyzed at various organizational divisions and institutes responsible for departmental research of the German Federal Ministry of Defense (BMVg). In 2017, the Defense Technology Foresight (WZA) business unit at Fraunhofer INT was tasked with drafting a process that would combine all technological insights obtained about the future and condense these to form a unified picture of the longer-term future of technology for the Bundeswehr. The comprehensive overview of research and technology (R&T) at the BMVg, which was reorganized over the same period, was expected to be supplemented by looking even further into the future considering the technology push. At the same time, the plan was to bring together an overarching R&T foresight community for the Federal Ministry of Defence's portfolio, providing a regular platform to discuss and develop a joint vision of the future.

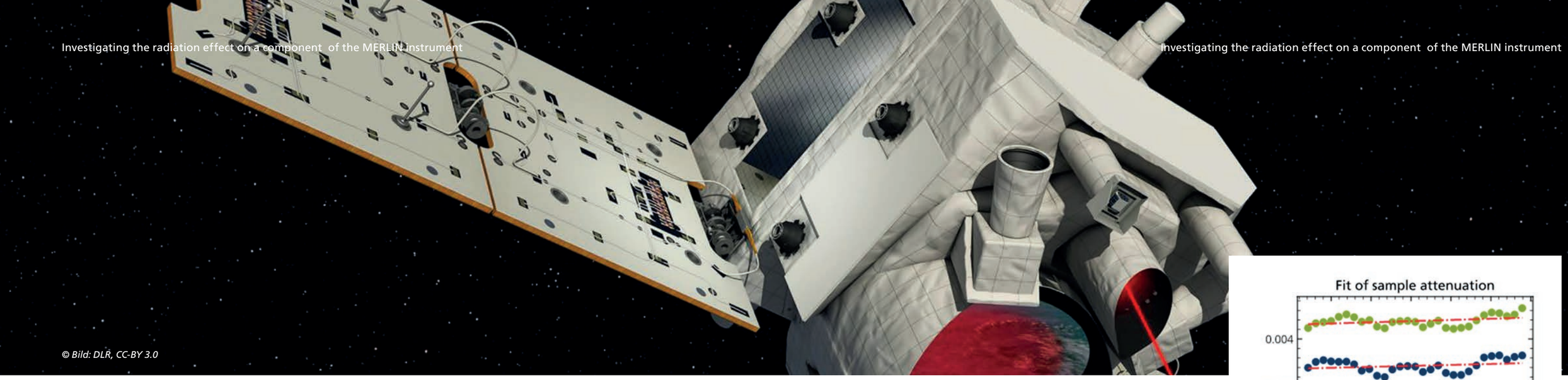
Fraunhofer INT set about developing a process to uniformly describe, characterize and assess future trends and research topics with subsequent information consolidation to form a comprehensive situation map for BMVg management. A key element of this process was the establishment of the Conference on the State of the R&T Future, which has taken place every year since 2018. Fraunhofer INT condenses the results of the conference into a compact visualization in the form of a "Picture-of-the-R&T-Future dashboard" and presents these annually to the R&T Steering Board that was established at state secretary level in 2017. This has become embedded as a regular process step in R&T planning at the BMVg.

BMVg Research Director, Ralf Schnurr, has personally chaired and moderated all three conferences that Fraunhofer INT has hosted thus far. In 2020, the group of participants was expanded once more and seniors at command level of the armed forces and those at the Bundeswehr technical centers as well as representatives of the individual defense-related research institutes were invited to participate. A total of around 90 people therefore attended the third conference, held on February 12 and 13, 2020. The 74 technology-related future topics had been assessed beforehand and were contributed in a standardized form by the institutes of the Fraunhofer Group for Defense and Security (VVS — now: Fraunhofer Segment for Defense and Security), the German Aerospace Center (DLR), the French-German Research Institute of Saint-Louis (ISL), the Bundeswehr research centers and universities, and the military medicine research institutes. Rather than having a series of contributing institutes, the 2020 conference was structured around the following thematic clusters to allow for an even more focused discussion: cyber/IT, soldier/protection, sensors, situation awareness, weapons, energy/materials, sea, aerospace. Representatives from all BMVg departments involved in R&T and the subordinate agencies for planning and equipment took part in the discussion and contributed to the opinion-forming process.

Given that attending the event in person — with extensive discussions in an enclosed space (conference room) and face-to-face interactions during intervals — is considered a core component, the Conference on the State of the R&T Future was not held in 2021 due to the pandemic. As soon as circumstances permit, the annual conferences will resume.

The Conference on the State of the R&T Future has become a key component of long-term departmental research planning at the BMVg. Fraunhofer INT has assumed the role of central hub for the newly established State of the R&T Future network.

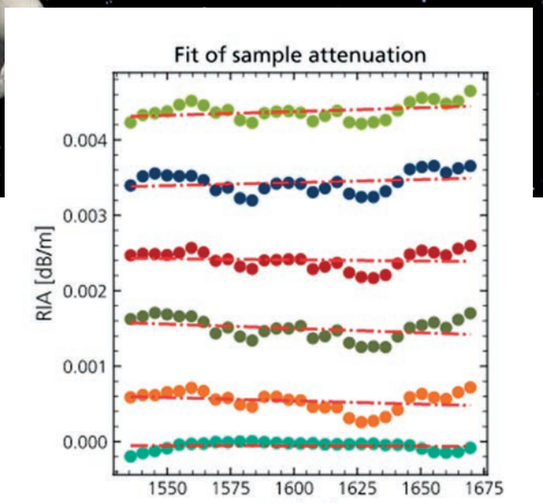
Investigating the radiation effect on a component of the MERLIN instrument



Investigating the radiation effect on a component of the MERLIN instrument

Artistic representation of the MERLIN satellite

Investigating the radiation effect on a component of the MERLIN instrument



Change in the radiation-induced attenuation (RIA) as a function of the wavelength for dose values, which increase along the y-axis. The broken red lines represent the fitted curves, the gradients of which represent the variables observed.

The MERLIN (»Methane Remote Sensing LIDAR Mission«) employs differential LIDAR (»Light Detection And Ranging«) to measure the spatial and temporal concentrations of methane in the atmosphere on a global scale. The LIDAR operates at nadir with a wavelength of 1645.55 nm. At this wavelength, methane has suitable absorption lines to enable a differential absorption analysis. Two laser pulses at slightly offset wavelengths are repeatedly emitted for this purpose. The first wavelength is absorbed by methane, while signals from the second wavelength act as a reference for other absorptions in the atmosphere. The absolute methane content can be calculated from the difference between the backscattered light signals. Knowledge of the two wavelengths and the accuracy of the relative pulse energies over the entire expected dynamic range are key for precise measurements.

A critical component for this analysis is an optical fiber in the instrument's calibration system, which transmits the signals of both wavelengths. As the concentration of methane can be determined from the difference between the reference and absorption wavelength signals, significant spectral changes to the transmission properties of the optical fiber must not occur during the mission.

Possible interference can occur as a result of the fiber's exposure to radiation in space, for example. It has been known for a long time that this affects light transmission in optical media. This depends, in particular, on the light's wavelength. If space radiation damaged the optical fiber in the MERLIN instrument, causing both wavelengths to experience different attenuation, this would affect the accuracy of the measurements or even make it impossible to obtain readings.

Fraunhofer INT was therefore commissioned by Airbus Defense and Space to conduct a study on the expected effects.

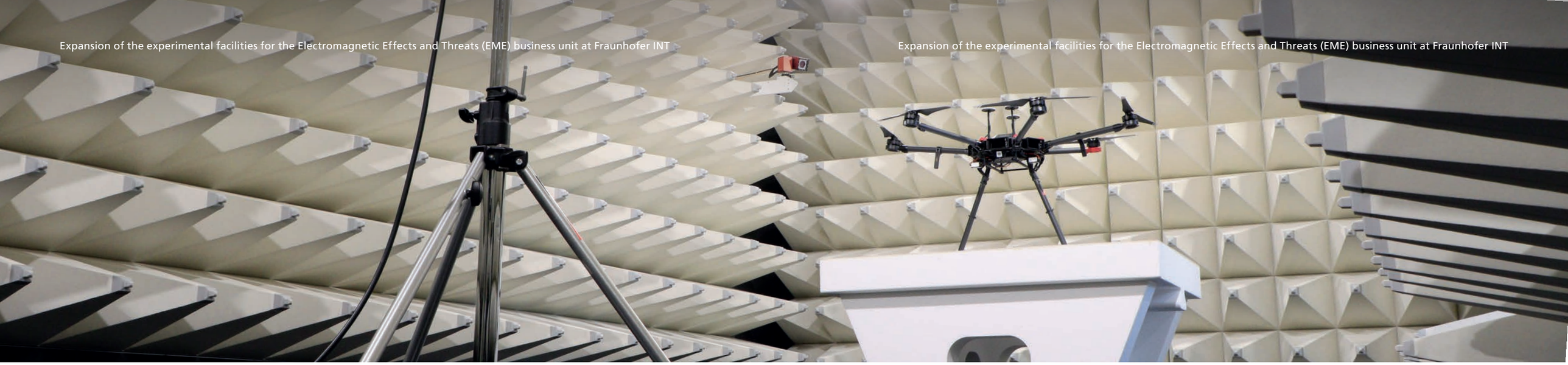
A particular challenge facing this analysis was the fact that even the smallest effects can have an impact on the mission application. The scale of the tolerable change in transmission between both wavelengths is only approx. 10-4. To complicate matters further, the different effect that must be detected for both wavelengths is very small and the fundamental effect of the attenuation increase in a comparatively short trial is only small.

The project's task was thus to develop a highly sensitive but stable setup that is above all designed for wavelength dependency. A combination of a white light source and spectrometer was used; the latter was particularly sensitive in the near-infrared range that was the focus of the investigation.

In several steps, different variants of the measurement setup were initially validated and tested to see whether the detection capability would be sufficient to supply the required data. In the next preliminary test, samples of different glass fibers were subsequently irradiated to calculate suitable parameters for dose, dose rate and sample length, for example. After finally determining the conditions, a sample of the glass fiber was provided for the actual test performed by Airbus DS; this sample will also be used in the calibration system of the MERLIN instrument.

In the evaluation of this irradiation, it was finally proven that the expected negative effect on the glass fiber intended for the project will be below the critical values for the mission by at least a factor of 10. There is thus nothing standing in the way of the planned implementation. In contrast, in another irradiation experiment conducted to compare another glass fiber sample, it was demonstrated that the effect on the glass fiber was significant and this would have excluded its use for MERLIN.

Acknowledgment: The German part of the MERLIN project is funded by the German Federal Ministry for Economic Affairs and Energy under DLR (German Aerospace Center) grant 50 EP 1601.



Expansion of the experimental facilities for the Electromagnetic Effects and Threats (EME) business unit at Fraunhofer INT

EMC test using a drone

Expansion of the experimental facilities for the Electromagnetic Effects and Threats (EME) business unit at Fraunhofer INT

Construction of a new experimental hall that houses an anechoic chamber for experimental EMC tests and a shielded room for the centralized operation of HPM sources.

In order to be able to comprehensively investigate electrical devices' interference resistance to high-power electromagnetic waves and their emitted interference, Fraunhofer INT has been equipped with several test environments and a range of signal sources as well as measuring equipment to support technical progress. An application was made to the internal Fraunhofer funding program for financial support to establish a new experiment hall with a view to systematically supplementing this portfolio of facilities. This new experimental hall comprises an anechoic chamber, which will primarily be used for standard electromagnetic compatibility (EMC) tests for electronic devices as well as EMC tests for automotive applications, and a shielded room for the operation of high frequency sources. By housing these facilities in one central location, the entire source portfolio can be flexibly and efficiently used in all test environments.

Planning/Construction phase

Planning and construction for the new experimental hall and its technical equipment took several years. The project's biggest challenges were notably planning the installation areas for the two shielded rooms due to limited available space and meeting other specific requirements, including the very high degree of planarity of the rooms' installation surface, the necessary climate control for the high frequency amplifiers and the supply of their electrical connected load. In terms of the actual construction of the experimental hall, there were constant delays despite detailed planning due to, for example, unexpected discoveries during civil engineering works and the Covid-19 pandemic.

Technical properties of the new chambers

To protect the surrounding environment, the electromagnetic fields emitted during device sensitivity tests must not be radiated outwards, which is why the walls of the new anechoic chamber must be tightly sealed against electromagnetic waves. The inside of the chamber is also lined with absorbers that absorb electromagnetic waves. It has the flexibility to be converted into either a fully anechoic chamber (FAC) or a semi-anechoic chamber (SAC) and can be used for many standardized EMC test procedures. For the latter operating mode, the modularly designed floor absorbers are removed, whereby reflections on the ground that occur in real life situations when a device is exposed to radiation outside are simulated. In addition, the chamber is suitable for supporting the business unit's other fields of activity, such as measuring antenna and custom-made field probes.

The new hall is also designed in such a way that all high-power sources available in the laboratory can be combined in a new amplifier chamber. Their central position in the laboratory area makes it possible to position all available test environments in close proximity next to the immediately adjoining new anechoic chamber and to provide a flexible switch matrix with the required test signals. The short cable paths minimize signal loss, which benefits the peak field strength that can be produced for the tests. The walls of the amplifier chamber are designed with the same shielding structure as the anechoic chamber because interfering radiation can result in the surrounding environment when operating high-power amplifiers. Due to waste heat being produced at the same time, efficient climate control must also be ensured.

Technical equipment

Modular metallic exterior walls achieve the fundamental shielding effect for both chambers. On the inside of the anechoic chamber, a full-surface lining of ferrite and pyramid absorbers also reduces unwanted reflections up to frequencies of 40 gigahertz. A turntable with a diameter of 1.5 meters and a load capacity of 500 kilograms as well as an antenna mast with automated polarization switching are also installed. In addition, the anechoic chamber is equipped with GPS signal simulators for test specimens and fitted with special-purpose cameras for visual monitoring of the experiments. There is also fiber optic-based communications technology enabling observation of the inner workings of the test specimens via accessible data interfaces.

In order to be able to operate all high frequency sources in the amplifier chamber, this has an electrical connected load of 86 kilowatts. All cables running into the chamber are equipped with high frequency filters and climate control similar to that in a server room ensures that the waste heat produced by the equipment is removed. The high frequency sources, their control units and extensive switching equipment can be installed in nine 19-inch server racks.

Expansion of the experimental facilities for the Electromagnetic Effects and Threats (EME) business unit at Fraunhofer INT

New anechoic chamber

The expansion of the experimental facilities opens up new markets and research possibilities for the EME business unit.«

Dr. Marian Lanzrath,
Scientist at the EME business unit

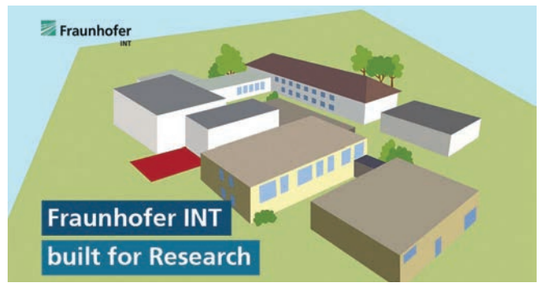
Amplifier room of the new hall

Benefit for the EME business unit

The anechoic chamber expands the test environments that have been operating for many years at the business unit, which include the electromagnetic reverberation chamber, TEM waveguide, a bulk current injection (BCI) setup and a small anechoic chamber that enables tests with and on antenna, comprising a floor with changeable reflective properties and a measuring distance of up to three meters. By lining the entire anechoic chamber with ferrite and pyramid absorbers (individually configured for use as an FAC or SAC), standards-based compliance and pre-compliance EMC tests in a frequency range of up to 40 gigahertz can be performed in the chamber; such a high frequency range is increasingly relevant for applications. In addition, the business unit's previous activities, such as measuring antenna or custom-made field probes, can now be carried out much more efficiently and extensively.

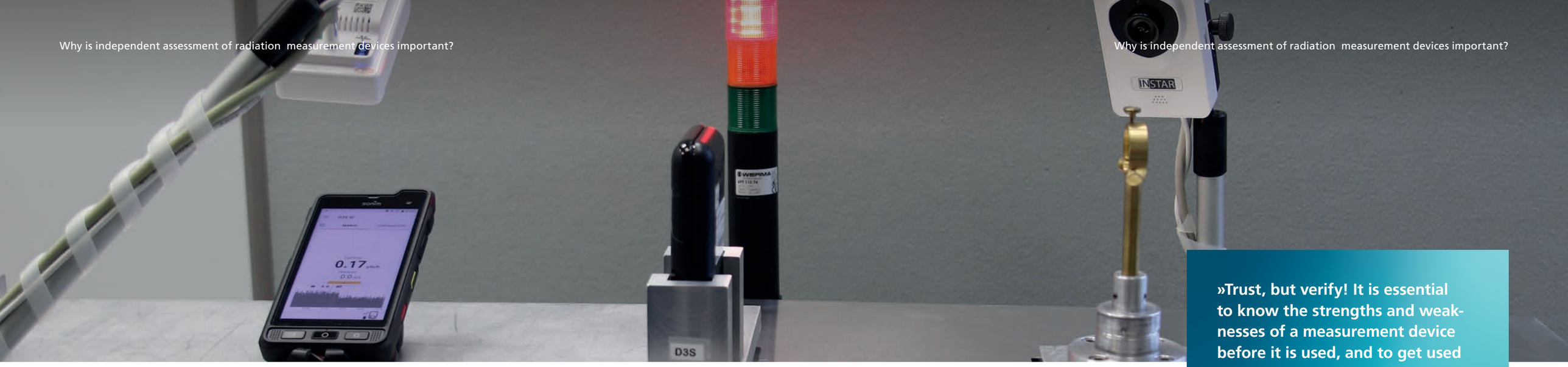
Upcoming work in 2021

NFollowing the handover of the laboratory area, commissioning the anechoic chamber as a new measurement environment is on the agenda for 2021. The technical equipment for the amplifier chamber also needs to be installed and commissioned. In addition, a new measuring station as well as storage areas for the necessary equipment and floor absorbers (when the chamber is being used as a SAC) are being built in front of the anechoic chamber. Furthermore, work on the existing test environments must also be carried out so that the signal pathways from the amplifiers to the test environments are as short as possible. To that end, the large TEM waveguide — measuring approx. 12 meters in length and around four meters in width and height — must be rotated 180° within the existing shielded hall. To accomplish this, the waveguide must first be disassembled into three subsections; these must then be individually rotated and moved to their final installation position before being reassembled. The electromagnetic reverberation chamber must also be moved in its entirety to the opposite corner of the shielded hall. After relocation to the new places of use, both test environments must be subsequently recommissioned and validated. Last but not least, the working group is planning work to digitalize the laboratory, which notably includes the automation of signal generation and distribution as well as the automation of measurement routines.



You can find an accompanying video project for the renovation on our YouTube channel, Fraunhofer INT.

Why is independent assessment of radiation measurement devices important?



Measurement setup with D3S in front of radioactive source in the source lifting mechanism of the QuTeSt (smartphone used as display unit and detector in front of alert light).

»Trust, but verify! It is essential to know the strengths and weaknesses of a measurement device before it is used, and to get used to operating it by carrying out exercises. The D3S shows promising results; however, the dose rate measurements may only used with caution.«

Dr. Monika Risse,
Deputy Group Manager NSD

Why is independent assessment of radiation measurement devices important?

Naturally occurring radioactivity is everywhere; however, artificial radiation sources are also widely used, for example in medicine. Radioactivity can be harmful to humans but we do not have a sensory organ to detect it. Humans are therefore reliant on measurement devices in situations involving nuclear or radioactive substances. The key tasks of such devices are monitoring, detecting and identifying radiation.

Measurement devices therefore need to meet different requirements depending on the application scenario, which is why a multitude of different devices exist. There are different device classes for different applications, for example personal radiation dosimeters (PRDs) and hand-held radionuclide identification devices (RIIDs). Spectroscopic personal radiation detectors (SPRD) represent a class in between. If you consider, for example, a scenario in which a radiation source of unknown origin is detected, a collective requirement for all measurement systems is the ability to deliver reliable results within a short time-frame. When evaluating the measurement results, it is important to be able to assess how reliable the device results are. Qualification measurements in accordance with existing, defined test procedures can provide valuable information on the quality of results. The results of such tests inform users and manufacturers how reliably a measurement device can detect, locate or identify radiation sources. It is also critical to become familiar with all aspects of a device prior to its use and to practice with radiation sources.

A measurement device that is available on the market for these tasks is the D3S by Kromek. This article presents the test results which were obtained using the QuTeSt (**Qualification Test System for Radiation Detection Devices**) developed by the Nuclear Security Policy and Detection Techniques (NSD) business unit and which was then used to assess the device's performance. The D3S can be used both as a PRD and an RIID. There are different measurement standards for these device classes, which form the basis for testing the devices. Many years of experience in device testing has resulted further, additional tests that provide an even more detailed picture of the reliability of a device.

Qualifications tests are performed with regard to different functional areas, for example in relation to false alarms and false identifications, the general triggering of an alarm, the accuracy of the photon measurement results, the duration until the alarm is triggered, the measurement device's response to radiation outside the measurement range specified by the manufacturer or even in terms of a neutron detector's response behavior to gamma radiation. For example, the neutron component of the D3S proved to be insensitive to the influence of a very strong gamma source and no neutron alarm was triggered. The most important measurement standards for these qualification tests are those of the American National Standards Institute (ANSI) and the International Electrotechnical Commission (IEC) as well as the procedures developed as part of the EU research project *»ITRAP+10« (Illicit Trafficking Radiation Detection Assessment Program + 10).*

The D3S comprises two components: the detector part (see the measurement setup image), which includes a cesium iodide gamma detector and a lithium-based neutron component, and a smartphone linked to the detector via Bluetooth that acts as a data processing and display unit. The detector part is shaped like a smartphone and allows first-line responders to carry it on their body.The measurement results are issued audibly, visually and via a vibration alarm on the smartphone. Tests were performed on two different generations of D3S: one D3S from 2016 (old D3S), which already underwent very extensive testing, and one D3S from 2019 (new D3S). The old D3S originally used firmware version 3.31, but the firmware has been updated so both devices now have firmware 3.77. Both, a comparison between two different hardware versions (2016 and 2019) and between two different firmware versions was thus possible. The latest firmware version is notably characterized by several changes regarding how the dose rate is determined. Considering the influence of the firmware on the measurement results is of particular interest because measurement systems must always be considered as a whole. A good detector material alone is no guarantee of a reliable and accurate measurement, and a very good analysis routine can provide quite a good result even using the spectrum of a detector material that has a lower resolution or is less efficient. Device characteristics also cannot be considered individually and independently from each other. For example, inaccuracies in the photon measurement results have an effect on identification results as well as on the behavior of the measurement device outside the measurement range specified by the manufacturer. It is also important to perform tests over the entire gamma energy range and for different dose rates.

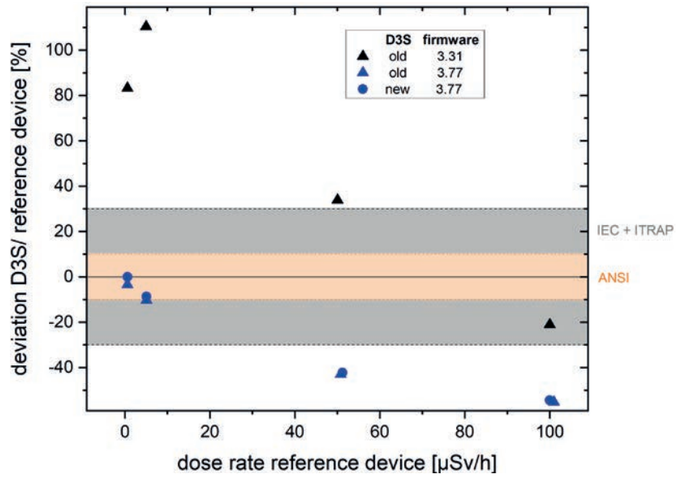
In terms of the accuracy of dose rate measurements, it is necessary to note that this device class does not involve calibrated radiation measurement devices; these are not used in radiation protection and therefore, measurement standards

D3S in front of radioactive source (yellow) in the source holder of the source lifting mechanism of the QuTeSt.

generally allow for greater tolerance in terms of accuracy. The table provides an overview of the requirements for RIIDs specified by different measurement standards. While the ANSI standard specifies a test using only one isotope, the IEC and ITRAP+10 standards both cover a significantly larger energy range using two additional isotopes. The accuracy of the dose rate measurement results should be tested up to the maximum specified by the manufacturer. According to the product information, the maximum for the D3S is 15 µSv/h for the 2016 device and 20 µSv/h for the 2019 one.

During the tests, the true dose rates were calculated using a calibrated reference instrument and the measurements were then compared. The measurement results for 137Cs are presented in the graph; the displayed measurements are the averages of 30 individual and independent measurements. The results of the old and new D3S using the same, new firmware correlate very closely to the reference values. However, the results using the old firmware deviate significantly. For 5 µSv/h, the deviation is greater than 100% and, with the exception of the measurement for 100 µSv/h, all measurements recorded lie outside of the permitted tolerance range. It is striking that conformity of the new firmware in the range below 20 µSv/h is very good and lies within ± 10% stipulated by ANSI. The device would therefore pass the test according to the ANSI standard for RIIDs. However, the deviation at 100 µSv/h was over 50%. The measurement recorded was far too low, which could lead to a seriously inaccurate risk assessment of the actual situation. With regard to the IEC and ITRAP+10 standards, the device does not pass the tests in any configuration.

Before using a radiation measurement device, it is therefore necessary to know its performance capacity, not least to protect first-line responders. The results of independent laboratories, which perform tests according to international standards and evaluate the results, are used for this purpose. Using the QuTeSt, Fraunhofer INT is in the position to perform such tests.



Dose rate values measured from three measurement series using the D3S compared with the true values for Cs-137. Orange range: permitted variance for RIID devices in accordance with ANSI measurement standards. Gray range: permitted variance for RIID devices in accordance with IEC measurement standards and ITRAP+10 test procedures. The error bars are smaller than the symbols and therefore do not appear on this graph.

Overview of the requirements for the accuracy of dose rate measurements with RIID devices for the different standards and test methods

	test with isotope					
test procedure	**^{241}Am**	**^{137}Cs**	**^{60}Co**	**test range**	**test dose rate values**	**tolerance [%]**
ANSI N42.34-2015	–	x	–	1 µSv/h – DL_{max}	25% and 75% of every scale or decade	± 10
IEC 62327:2017	x	x	x	1 µSv/h – DL_{max}	1 µSv/h, 10 µSv/h, 70 % of DL_{max}	± 30
ITRAP+10	x	x	x	0,1 µSv/h – DL_{max}	0,5 µSv/h, 5 µSv/h, 50 µSv/h, 100 µSv/h; higher measurements tolerable, if DL_{max} > 100 µSv/h	± 30

DL_{max}: maximum specified by the manufacturer

Others

Fraunhofer Space Alliance

Institute for Technology Analysis and Foresight in the Field of Security Research at RWTH Aachen University

Shortly noted

Fraunhofer Space Alliance

The Fraunhofer Space Alliance was established to pool together all technological expertise in the field of aerospace from across the Fraunhofer Institutes with the aim of providing customers and cooperation partners with a single, convenient contact point for all aerospace matters. The Alliance currently has 17 member institutes.

For the Fraunhofer Space Alliance, 2020 was a year of self-reflection. While the aviation industry — which intersects and overlaps on many levels with the aerospace industry in terms of stakeholders — struggled and continues to struggle with massive losses and a partial halt to air traffic, the space sector was less severely impacted by the COVID-19 pandemic. Nevertheless, many workshops and trade show visits were canceled or postponed and then canceled due to restricted mobility globally or difficulties in safely organizing events with high numbers of visitors.

Despite this, the Fraunhofer Space Alliance identified the potential of digitalizing what were previously in-person formats. This was exploited for several in-house workshops but also public events, for example for the ILA Goes Digital organized by the German Aerospace Industries Association (BDLI) and the Industry Space Days held by the ESA. The Alliance and its member institutes were represented at both events. Unfortunately, it was noted at the end of 2020 that the scope and return of digital formats still did not match that of traditional in-person events. However, this could improve in the future if both event organizers and visitors become more accustomed to the new formats and new, more immersive ways of presenting content are developed.

One highlight in a year that was lacking in positives on the whole was the Alliance's appearance at the Fraunhofer Solution Days. The Alliance made good use of this event (see also page 64) with a joint exhibition, providing an overview of the Alliance and contributions from a total of five institutes: an athermal, free-form reflector telescope (Fraunhofer IOF), a CubeSat GPS antenna (Fraunhofer IIS) and the nanosatellite ERNST (Fraunhofer EMI in partnership with Fraunhofer IOSB and Fraunhofer INT).

Space Alliance member institutes

Member institutes

- 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, Ernst-Mach-Institut, EMI
- Fraunhofer Institute for Laser Technology ILT
- Fraunhofer 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 Center for Applied Photonics CAP

Thomas Loosen

Institute for Technology Analysis and Foresight in the Field of Security Research at RWTH Aachen University

The aim of the Institute for Technology Analysis and Foresight in the Field of Security Research at RWTH Aachen University is to introduce students to quantitative and qualitative future research methods within the framework of applied teaching and learning concepts. Students not only learn about the epistemological foundation of these future research methods but also analyze the extensive canon of methodology in terms of its suitability and optimization possibilities. The institute's research focus is the analysis of foresight processes in the field of technology as well as the adaption and new and further development of corresponding processes and methods. The knowledge obtained from the research on an ongoing basis supports scientifically substantiated decision-making on matters associated with the temporal development of technologies.

The institute's activities and methodological work were gradually advanced over the past years. Due to the COVID-19 pandemic and the resulting restrictions, all of the institute's modules were successfully converted to a digital format. In this context, the didactic approach to teaching and learning concepts, among other things, was adapted to the new, virtual conditions.

Modules are offered in the form of lectures during the semester as well as one- or two-day block events (seminars). In the 2020 summer semester, 111 students enrolled in the online lecture-based module »Methods of future research — technology analysis«. In the 2020/2021 winter semester, the online lecture-based module »Methods of future research — technology foresight« was taken by 164 students. In addition to lecture-based modules, the institute offers seminar-based modules; these seminars take a deep dive into specific aspects of the lectures. The seminar-based modules "Ethics in technology« and »Epistemology and philosophy of science for engineers« took place in the summer and winter semesters, respectively. As both the lectures and seminars are highly popular, new seminar formats will be added in the coming year. To that end, a seminar-based module on safety research and future research as well as one on data-driven foresight have been developed for the summer and winter semesters, respectively.

Another success is the establishment of the lecture series »Methods of future research« at the University of Applied Sciences Ravensburg-Weingarten. Students on the »Technology Management« course attend the lectures led by Prof. Lauster and learn about the methodological principles of future research following an application-based approach. The lecture series takes place once a year in a block format and is well received by the students.

In 2020, the cooperation between the Institute for Technology Analysis and Foresight in the Field of Security Research and Fraunhofer INT was further strengthened. Scientists at Fraunhofer INT increasingly supported the teaching activities, while students worked on their bachelor's and master's theses at Fraunhofer INT, thus generating additional synergy effects. Some students from the modules also completed internships or were employed as research assistants.

In April 2020, a doctoral thesis supervised by Prof. Lauster was successfully completed. As part of this doctoral thesis, Dr. Stephanie Hansen-Casteel developed an indicator-based model to prospectively measure technology acceptance. Furthermore, since 2019, Christian Hemmers has been working on a doctoral thesis that focuses on the foresight processes for SMEs.

Christian Hemmers, Dr. Stephanie Hansen-Casteel

Shortly noted

Fraunhofer Solution Days 2020

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The Fraunhofer Solution Days were held on October 26-29, 2020. The fully virtual Fraunhofer event consisted of presentations on current technology highlights and holistic solutions. Participants could also visit a virtual exhibition and participate in live chats with Fraunhofer experts. Each one of the four days addressed a topic that is extremely relevant for innovative strength in Germany and Europe. The four topics were: health management, digital economy, plant and machine construction, and mobility. The presentations and exhibits were available on demand via the media library until October 2021.

Virtual Fraunhofer INT booth at Solution Days 2020

Fraunhofer INT presented the KATI system for the topic "digital economy" on the second day. Three 3D models based on visualizations from the KATI system were shown for the first time. For example, the geographical distribution of publications on the topic of additive manufacturing was presented. KATI is an IT- and data-based assistance system that was developed as part of a research project at Fraunhofer INT. The aim of KATI is to make literature research for technology foresight more efficient. Videos in which the 3D models are presented can also be found on the Fraunhofer INT YouTube channel. You can access the Fraunhofer INT YouTube channel using the QR code on the following page.

DWT Conference: Applied Research for Defense and Security in Germany

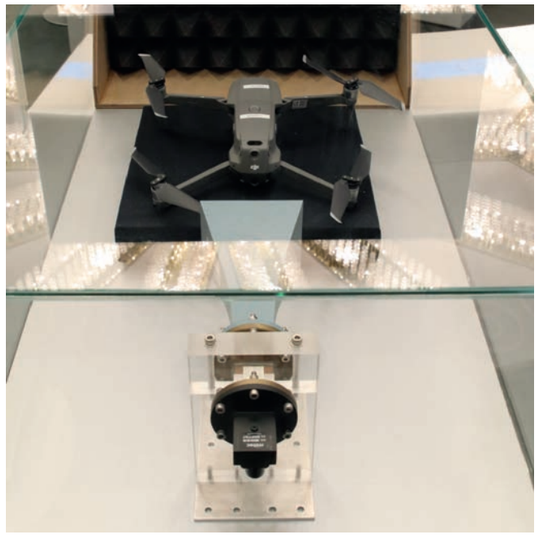
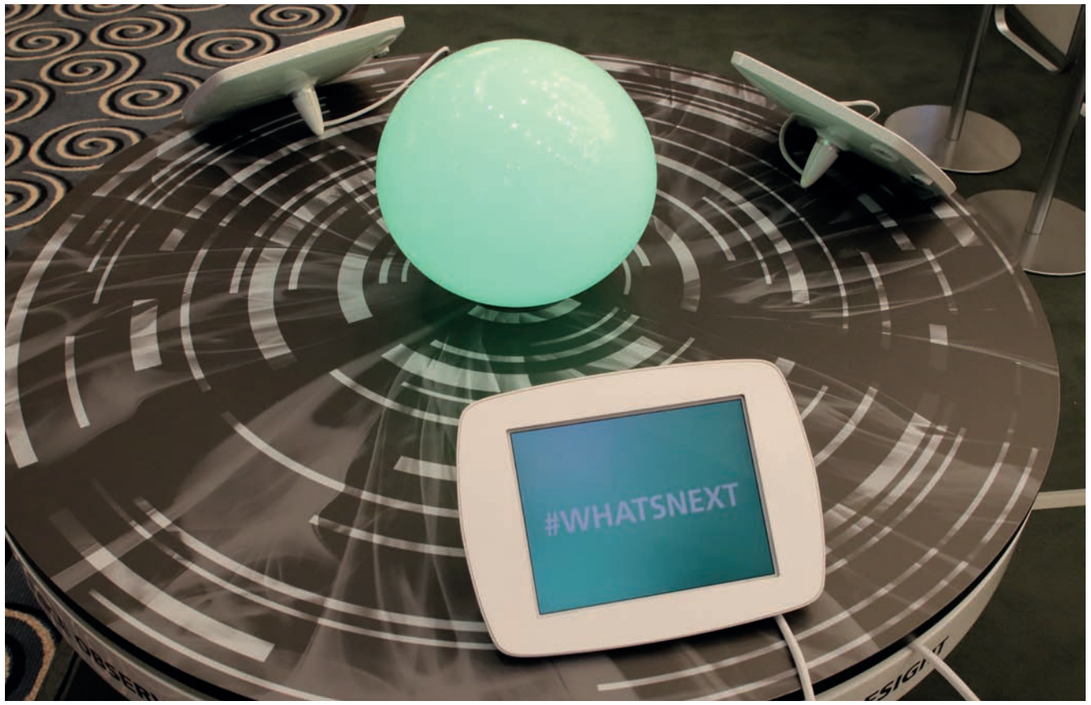


Exhibit on drone defense by means of HPM

Shortly before in-person events were stopped due to the COVID-19 pandemic, the "Applied Research for Defense and Security in Germany" conference held by the German Association for Defense Technology (DWT) took place aon March 3-5, 2020, at the Maritim Hotel in Bonn. The conference program comprises panel and poster sessions, as well as an exhibition, and takes place every two years.

Fraunhofer INT once again participated in the event. This year, the institute presented an ex-hibit on drone defense using high power electromagnetic radiation (HPEM). Visitors could also demo the KATI assistance system for technology foresight developed at Fraunhofer INT, run individual searches with the institute's scientists, and analyze and discuss the results. The crystal ball exhibit "Augmented Technology Foresight" was also included, which demonstrated various future technological scenarios. Fraunhofer INT presented as part of the joint stand of the Fraunhofer Segment for Defense and Security (VVS). In addition, Prof. Michael Lauster, Director at Fraunhofer INT, opened the session on the second day with the presentation "Initiator, Motivator, Innovator — Comments on the Role of the Bundeswehr in the Innovation Process". The conference is Germany's largest defense- and safety-related conference in the field of research and technology and 2020 marked its fourth edition.



Augmented Reality Foresight exhibit

Fraunhofer INT on YouTube

DAs numerous trade shows and events were canceled due to the pandemic, Fraunhofer INT decided to focus its efforts in 2020 on strengthening its YouTube presence with the aim of continuing to provide the public with interesting content on its research projects. Among other things, 2020 marked the start of the video series "Young researchers at Fraunhofer INT". This series presents bachelor to PhD theses that are worked on at or in cooperation with Fraunhofer INT. To make up for a lack of trade show appearances, viewers can also visit the channel to watch videos on the new, 3D-printed exhibits of the KATI system. Moreover, to mark the International Day of Disabled Persons on December 3, an interview with the institute's Representative for Disabled Employees, Dr. Marcus John, was released. In this video, Dr. John discusses his responsibilities and talks about working with a disability at Fraunhofer INT.

Scan the code and take a look:

Appendix

Appendix

Modules and other lectures at universities

Bantes, R.; Wiemken, U.: » Technik und Gesellschaft « master's degree seminar, Bonn Rhein-Sieg University of Applied Sciences, Sankt Augustin, Germany, spring semester 2020

Bantes, R.; Wiemken, U.: »Technikjournalismus«, bachelor's degree seminar, Bonn Rhein-Sieg University of Applied Sciences, Sankt Augustin, Germany, spring semester 2020

Chmel, S.: » Physics« module and tutorial, »Naturwissenschaftliche Forensik« bachelor's degree (second semester), Bonn Rhein-Sieg University of Applied Sciences, spring semester 2020

Chmel, S.: » Measuring Techniques« module and tutorial, »Naturwissenschaftliche Forensik « bachelor's degree (third semester), Bonn Rhein-Sieg University of Applied Sciences, fall semester 2020/2021

Hemmers, C: »Methoden der Zukunftsforschung« tutorial, University of Applied Sciences Ravensburg-Weingarten, spring semester 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 for Rehabilitation Medicine, Berlin Academy for Community Medicine, January 20, 2020

John, M.: »Quantitative Methoden der Zukunftsforschung. Eine sehr kurze Einführung in Data Driven Foresight «, lecture as part of the »Methoden der Zukunftsforschung II« module of Prof. Dr. Dr. Lauster, RWTH Aachen University, May 28, 2020

John, M. & Baaden, P.: »Where Do We Go Tomorrow? Publication and patent data analysis as a tool for technology foresight«, Lecture as part of the » Methods in Management Research« module of Prof. S. Bröring, University of Bonn, December 8, 2020

Jovanović, M.: »Recherchieren von seriösen und sinnvollen Quellen« workshop, modules C6 I Technology and Society and C6 U Environment and Society, Bonn Rhein-Sieg University of Applied Sciences, online, April 15, 2020

Jovanović, M.: »Bibliometric methods and their application on the publication activities of the former Yugoslav republics« lecture, University of Novi Sad, Serbia, online, November 30, 2020

Kohlhoff, J.; Hemmers, C.: Tutorial on »Methoden der Zukunftsforschung « as part of the »Technik Management & Optimierung« master's degree, University of Applied Sciences Ravensburg-Weingarten, online course, June 23, 2020 – July 14, 2020

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

Lauster, M.: »Methoden der Zukunftsforschung II«, RWTH Aachen University, spring semester 2020

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

Lauster, M.: »Engenieure/Soziologen zur Technologiefolgenabschätzung« joint seminar, RWTH Aachen University, fall semester 2019/2020

Lauster, M.: »Technikethik« seminar, RWTH Aachen University, spring semester 2020

Lauster, M.: »Methoden der Zukunftsforschung« module, University of Applied Sciences Ravensburg-Weingarten, spring semester 2020

Metzger, S.: »Experimental Techniques in Particle Physics« course, master's degree in »Physik«, RWTH Aachen University, fall semester 2020/2021

Wirtz, H.: »Investition und Finanzierung«, bachelor's degree program »Betriebswirtschaftslehre (part-time)«, Fresenius university of applied sciences, spring semester 2020, fall semester 2020/21

Wirtz, H.: »Controlling und Qualitätsmanagement«, bachelor's degree program »Automotive and Mobility Management«, Fresenius university of applied sciences, fall semester 2019/20

Wirtz, H.: »Controlling und Qualitätsmanagement«, bachelor's degree program »Tourismus & Hospitality Management«, Fresenius university of applied sciences, spring semester 2020

Wirtz, H.: » Qualitäts-, Change und Innovationsmanagement«, bachelor's degree program »Betriebswirtschaftslehre (part-time)«, Fresenius university of applied sciences, fall semester 2019/20, spring semester 2020, fall semester 2020/21

Wirtz, H.: »Qualitäts-, Change und Innovationsmanagement«, bachelor's degree program »Betriebswirtschaftslehre«, Fresenius university of applied sciences, fall semester 2019/20

International cooperation

Adami, C., Kaluza, B., Michael, K., Pastuszka, H.-M., Suhrke, M.: European Defence Agency (EDA), service contract »High Power Electromagnetic Munitions — HPEM« (19.RTI.NP.419), collaboration with Fraunhofer Institute for High-Speed Dynamics, Ernst-Mach-Institut, EMI, 2020–2021, online expert workshop on HPEM, EDA, October 1–2, 2020

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

Berchtold, C., Freudendahl, D., Grigoleit, S., Müller, L., Schmitz, S., Walther, G.: Horizon 2020 SHAPES (Smart & Healthy Ageing through People Engaging in Supportive Systems) project, 36 project partners

Berchtold, C., Grigoleit, S., Kaluza, B., Chmel, S..: Horizon 2020 IN-PREP (An Integrated next generation PREParedness programme for improving effective inter-organisational response capacity in complex environments of disasters and causes of crisis) project, 19 project partners.

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

Bornhöft, M. C., Chmel, S.: Horizon 2020 STRATEGY (Facilitating EU pre-standardization process through streamlining and validating interoperability in systems and procedures involved in the crisis management cycle) project, 23 project partners

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

NEO business unit: Involvement in the RADNEXT EU project

Huppertz, G., Lieder, E.: EDA Technology-Foresight Workshop on Hypervelocity Systems, European Defence Agency (EDA, Brussels, Belgium), Isdefe (Madrid, Spain) and Fraunhofer INT (Euskirchen, Germany), online, October 12–13, 2020

Huppertz, G., Lieder, E., Pastuszka, H.-M.: European Defence Agency (EDA), service framework contract »Technology Foresight Follow-on (TFFO) « (17.ESI.OP.373), collaboration with Ingeniería de Sistemas para la Defensa de España (Isdefe, Spain), 2018–2021, online foresight workshops on »autonomous systems«, EDA, September 22–23, 2020 and on »Hypervelocity Systems« , EDA, 12./13.10.2020

Jovanović, M.: Aslib Journal of Information Management

Jovanović, M.: ICTeSSH - International Conference on ICT enhanced Social Sciences and Humanities 2020

Köble, T.: ESARDA VTM Working Group

Kuhnhenn, J.: Session Chairman at RADECS 2020

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

Neisser, F.: FIRE-IN (Fire and Rescue Innovation Network) project, 15 European project partners

Pastuszka, H.-M., Huppertz, G.: EDA Technology-Foresight Workshop on Autonomous Systems, European Defence Agency (EDA, Brussels, Belgium), Isdefe (Madrid, Spain) and

Fraunhofer INT (Euskirchen, Germany), online, September 22–23, 2020

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

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

Suhrke, M., Adami, Ch.: Collaboration with the NATO STO SCI-294 task group »Demonstration and Research of Effects of RF Directed Energy Weapons on Electronically Controlled Vehicles, Vessels, and UAVs«, 9 nations

Vollmer, M., Berchtold, C., Bornhöft, M.C., Chmel, S.: EU H2020 STRATEGY (Facilitating EU pre-standardization process through streamlining and validating interoperability in systems and procedures involved in the crisis management cycle) project, 23 project partners

International reviewing activity

Alessi, A.: IEEE Transactions on Nuclear Science, ISSN: 0018-9499, IEEE

Alessi, A.: Optical Materials Express, OSA

Alessi, A.: IEEE-Access, IEEE

Alessi, A.: Applied Sciences, MPDI, ISSN 2076-3417

Alessi, A.: Materials Chemistry and Physics, ISSN 0254-0584, Elsevier

Alessi, A.: Journal of Non-Crystalline solid, ISSN 0022-3093, Elsevier

Alessi, A.: Radecs 2020

Berchtold, C.: Journal of Contingencies and Crisis Management

Berchtold, C.: International Journal of Disaster Risk Science

Kuhnhenn, J., Steffens, M.: NSREC 2020

Kuhnhenn, J.: Optical Fiber Technology, ISSN: 1068-5200, Elsevier

Kuhnhenn, J.: IEEE Transactions on Nuclear Science, ISSN: 0018-9499, IEEE

Kuhnhenn, J.: Journal of Physics Communications, Online ISSN: 2399-6528, Benjamin Sheard

Metzger, S.: IEEE Transactions on Nuclear Science

Metzger, S.: RADECS 2020 conference

Metzger, S.: Advances in Space Research

Steffens, M.: Applied Radiation and Isotopes, ISSN: 0969-8043, Elsevier

Suhrke, M.: IEEE Transactions on Electromagnetic Compatibility

Thorleuchter, D.: Applied Sciences

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.: Systems

Thorleuchter, D.: Technological Forecasting & Social Change

Thorleuchter, D.: Journal of Manufacturing Technology Management

Thorleuchter, D.: Symmetry

Thorleuchter, D.: Journal of King Saud University - Computer and Information Sciences

Collaborations with committees

Chmel, S.: Coordinator of the Fraunhofer EU Network

Chmel, S.: Head of »AG Management" of the Fraunhofer EU Network

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

Kuhnhenn, J.: Program committee for RADECS 2020

Lauster, M.: R&T control board BMVg

Lauster, M.: BMVG AG R&T-Strategy

Lauster, M.: R&T-Counselor BMVg A III

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

Neisser, F.: Member of the United Nations Office for Disaster Reduction (UNDRR) Expert WorkingGroups for the Global Risk Assessment Framework (GRAF)

Neisser, F.: Member of the Bonn Network International Civil Protection and Disaster Risk Reduction

Steffens, M.: Awards committee of RADECS 2020

Suhrke, M.: Fraunhofer INT Ombudsperson

Thorleuchter, D.: Spokesperson of the Panel on the Operation of Information and Communication Systems at the Gesellschaft für Informatik e.V. (German Informatics Society — 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 Fourth International Conference on Intelligent Systems and Computer Vision (ISCV) 2020, 09. – 11. 06. 2020, Fez, Morocco

Thorleuchter, D.: Program Committee of the Fourth International Conference on Intelligent Computing in Data Sciences (ICDS) 2020, 21. – 23. 10. 2020, Fez, Morocco

Participation in standardization work

Adami, Ch.: NA140-00-19AA
Creation of the German Defense Equipment (VG) standards VG96900-96907, NEMP and lightning protection

Adami, Ch.: NA140-00-20-02UA
Creation of the German Defense Equipment (VG) standards VG95370 et seq., electromagnetic compatibility

Adami, Ch.: NATO HPM Standardization

Höffgen, S.: CTB Radiation Working Group

Köble, T.: DIN and VDE DKE/GK851, activity measurement devices for radiation protection

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

Kuhnhenn, J.: ESA Photonics Working Group

Suhrke, M.: National representative of the IEC Joint Working Group Reverberation Chamber

Suhrke, M.: GAK 767.3/4.4
TEM waveguide/reverberation chamber, DKE German Commission for Electrical, Electronic & Information Technologies of DIN and VD

Presentations

Adami, Ch.
»HPEM technologies and components«, »HPEM targets and vulnerabilities«, "High Power Electromagnetic Munitions (HPEM) « EDA workshop, October 1-2, 2020

Baaden, P.:
»Bridging trends and science: Cluster analysis for topic extraction within the circular economy«, GTM 2020 (Global TechMining Conference)

Bantes, R., Neupert, U., Pastuszka, H.-M.:
»Zukunftsthemen WTV 2019«, 3rd Conference on the State of the R&T Future 2020 BMVg A II, Fraunhofer INT Euskirchen, February 12-13, 2020

Berchtold, C. & F. Neisser:
»EU International cooperation & procedural interoperability in wildfire management. Can it be improved through lessons learned and overseas experience? «, DRK Fachtagung Katastrophenvorsorge [GRC Disaster Preparedness Symposium], Berlin, Germany / online, October 19, 2020

Carrasco, E., Freudendahl, D., Schmitz, S.:
»Foresight exercise on future technologies«, first dialog workshop in SHAPES, virtual, May 12, 2020

Cesbron Lavau, L.
»Response of the UAV Sensor System to HPEM Attacks«, EMC Europe 2020, September 23-25, 2020

John, M.:
»Von Daten Und Bildern. Strategische Technologieentscheidungen mit KATI unterstützen«, annual meeting of the Scientific Information Managers of the Fraunhofer-Gesellschaft, October 20, 2020

Jovanović, M.:
»WoS/Scopus/Dimensions: Anwendungsfälle und Perspektiven« lecture, virtual Fraunhofer Network meeting and specialist information forum, online, October 22, 2020

Köble, T.:
»Vorstellung der Aktivitäten/Forschungsvorhaben im Bereich Nukleare Verifikation«, German Federal Foreign Office, Berlin, Germany, January 23, 2020

Köble, T.:
»Neutronenstrahlung«, »Radiologische Risiken« seminar of the German Federal Office of Civil Protection and Disaster Assistance (BBK), virtual, November 17, 2020

Kuhnhenn, J.:
»Co-60 total dose testing – Old and new challenges«, invitational lecture on G-RAD(Grenole Radiation Testing of semiconductors devices and systems): online workshop, December 9-10, 2020

Lanzrath, M.:
»UAS-HPEM-Wechselwirkungsuntersuchungen«, video presentation at the HPEM state of affairs meeting 2020, WTD 81 Greding, Germany, December 8, 2020

Lanzrath, M.:
»HPEM-Verwundbarkeit moderner Energieversorgungssysteme« thesis defense, University of Duisburg-Essen, July 2, 2020

Müller, Larissa; Sendrowski, Philip:
»Spielerisch in die Zukunft – Gamingmethoden zur bedarfsgerechten Technologievorausschau und Strategieentwicklung auf Augenhöhe«, Zukunftsforum Grüne Woche 2020 [Future Forum Green Week 2020], Berlin, Germany, January 22, 2020

Neupert, U., Pastuszka, H.-M.:
»Wehrtechnische Zukunftsanalyse für die Bundeswehr«, video podcast for the National General/Admiral Staff Officer Course (LGAN 2019), Bundeswehr Command and Staff College (BwCSC) Hamburg, Germany, fall 2020

Pastuszka, H.-M.:
»Technologien digitaler Landstreitkräfte«, online keynote speech for RENK AG, Augsburg, Germany, December 8, 2020

Lauster, M.:
»Eine Geschichte aus der Zukunft« DND portfolio workshop, Aachen, February 10, 2020

Lauster, M.:
Protecting the space infrastructure, DWT (German Association for Defense Technology) SGW (Center for Studies and Conferences) »Angewandte Forschung für Verteidigung und Sicherheit in Deutschland [Applied Research for Defense and Security in Germany]« conference, Bonn, Germany, December 3–5, 2020

Lauster, M.:
»Technik.Ethik.Trends. Warum wir Technologien entwickeln – und weshalb wir es weiterhin tun sollten«, Thoughts on possible objectives for technological progress, Freiburg, Germany, May 5, 2020

Lauster, M.:
»Robustheit, Resilienz und dissipative Strukturen – was Resilienzforschung mit Thermodynamik zu tun hat«, institute director conclave, Dresden, Germany, October 15, 2020

Lauster, M.:
»Some Aspects of Future Mobility – Individual, Autonomous, Sustainable«, Fraunhofer Solution Days, October, 29 2020

Lauster, M.:
»Robustheit, Resilienz und dissipative Strukturen – was Resilienzforschung mit Thermodynamik zu tun hat«, meeting of the advisory board of the Association for Innovation and Research, November 12, 2020

Lauster, M.:
»(Overview) about Germany's Space Sector« , 2nd Oppurtunities Forum Scotland, Ready for take off? Scotland & Germany Space Roundtable, November 25, 2020

Metzger, S.:
»LIDAR als Verifikationstool für nukleare und chemische Rüstungskontrolle«, Physics Day, RWTH Aachen University, January 24, 2020

Neisser, F.:
»Governance challenges in changing environments Cross-organizational and multi-national wildfire risk management«. 11th International Sustainability Transition Conference, Wien / Online, August 20, 2020

Pusch, T.:
»Charakterisierung eines Referenztestaufbaus für die HPEM-Normenentwicklung«, emv digital, May 12, 2020

Pusch, T.:
»Soft-Skill Training: Giving a high-impact presentation«, Network Wide Event 1 MSCA-ETN PETER, May 28, 2020

Risse, M.:
»Qualification measurements of handheld radiation detectors for homeland security purposes«, 61st Annual Meeting Institute of Nuclear Materials Management INMM, virtual, July 16, 2020

Suhrke, M.
»HPEM-Effektoren«, Future R&T Situation Conference, February 12-13, 2020

Suhrke, M.
»Geschäftsfeld Elektromagnetische Effekte und Bedrohungen – Aktuelle Projekte«, INT seminar, November 18, 2020

Publications

Bantes, René:
Technology analyses and strategic planning: Dr. René Bantes, Head of the Technological Analyses and Strategic Planning department, Fraunhofer INT
In: Proll, R. Uwe (ed.): AFCEA 2020. Fraunhofer Institute for Technological Trend Analysis INT. Bonn, Germany: Behörden Spiegel Group, 2020, pp. 38

Barber, Liam; Cullen, David M.; Giles, M.M.; Nara Singh, B.S.; Mallaburn, M.J.; Beckers, Marcel; Blazhev, Andrey; Braunroth, Thomas; Dewald, Alfred; Fransen, Christoph; Goldkuhle, Alina; Jolie, Jan; Mammes, Franziska; Müller-Gatermann, Claus; Wölk, Dorothea; Zell, Karl Oskar:
Performing the differential decay curve method on Ɣ-ray transitions with unresolved Doppler-shifted components
In: Nuclear instruments and methods in physics research, Section A. Accelerators, spectrometers, detectors and associated equipment, Vol.950 (2020), Art. 162965, 6 pp.
DOI 10.1016/j.nima.2019.162965

Basu, Anwesha; Singh, A.K.; Nag, S.; Hagemann, G.B.; Sletten, G.; Herskind, B.; Wilson, A.N.; Rogers, J.; Ragnarsson, I.; Hübel, H.; Chmel, Sebastian; Janssens, R.V.F.; Carpenter, M.P.; Khoo, T.L.; Kondev, F.G.; Lauritsen, T.; Zhu, S.; Korichi, A.; Fallon, P.; Nyako, B.M.; Timar, J.:
Evolution of collective and noncollective structures in ^{123}Xe
In: Physical Review. C, Vol.101 (2020), No.2, Art. 024309, 22 pp.
DOI 10.1103/PhysRevC.101.024309

Berchtold, Claudia; Vollmer, Maike; Sendrowski, Philip; Neisser, Florian; Müller, Larissa; Grigoleit, Sonja:#
Barriers and facilitators in interorganizational disaster response: Identifying examples across Europe
In: International journal of disaster risk science, Vol.11 (2020), No.1, pp.46-58
DOI 10.1007/s13753-020-00249-y

Berchtold, Claudia; Walther, Gerald; Müller, Larissa; Cook, Michael (Contributor); Labor, Melanie (Contributor); Sarlio-Siintola, Sari (Contributor); Gonidis, Fotis (Contributor); Silva, Renato (Contributor); Rocha, Pedro (Contributor); Teles, Soraia (Contributor); Costa, Elísio (Contributor); Paúl, Constança (Contributor); Manso, Marco António Azinheira Morais Lourenço (Contributor); Guerra, Bárbara (Contributor):
Deliverable D3.7 - User requirements for the SHAPES platform
Euskirchen, 2020
URN urn:nbn:de:0011-n-6217679

Berchtold, Claudia; Haltern, Ulrich (peer reviewer); Germelmann, Claas Friedrich (peer reviewer):
Solidarity in the EU: Wishful thinking or status quo?: Analysing the paradox of EU solidarity and national sovereignty in civil protection in the context of Art. 222 TFEU (Solidarity Clause)
Hannover, Univ., Diss., 2019
DOI 10.15488/9245

Berky, Wolfram; Chmel, Sebastian; Friedrich, Hermann; Glabian, Jeannette; Köble, Theo; Risse, Monika; Schumann, Olaf; Bornhöft, Charlotte:
Testing facility for the qualification of measurement devices suitable for detecting nuclear and radioactive material: Poster presented at ICONS 2020, International Conference on Nuclear Security. Sustaining and Strengthening Efforts, Vienna, 10-14 February 2020
(International Conference on Nuclear Security - Sustaining and Strengthening Efforts (ICONS) <3, 2020, Vienna>)
2020
URN urn:nbn:de:0011-n-6219681

Beyerer, Jürgen (editor); Martini, Peter (editor); Gabel, O.; Fraunhofer Group for Defense and Security -VVS-:
Rise of artificial intelligence in military weapons systems: The need for concepts and regulations. Position paper
Munich: Fraunhofer-Gesellschaft, 2020.
URN urn:nbn:de:0011-n-5969677

Brandt, Heike; Freudendahl, Diana; Langner, Ramona:
Material trends: Anti-fogging and anti-icing polymer-based coatings
In: Werkstoffe in der Fertigung [Materials in Manufacturing], (2020), No. 2, pp. 3

Eriksen, Christine; Simon, Gregory L.; Roth, Florian; Lakhina, Shefali Juneja; Wisner, Ben; Adler, Carolina; Thomalla, Frank; Scolobig, Anna; Brady, Kate; Bründl, Michael; Neisser, Florian; Grenfell, Maree; Maduz, Linda; Prior, Timothy:
Rethinking the interplay between affluence and vulnerability to aid climate change adaptive capacity
In: Climatic Change, Vol. 162 (2020), No. 1, pp. 25–39
DOI 10.1007/s10584-020-02819-x

Freudendahl, Diana:
Blockchain living lab in the Rhineland region: Dr. Diana Freudendahl, Scientist, Corporate Technology Foresight business unit, Fraunhofer INT
In: Proll, R. Uwe (ed.): AFCEA 2020. Fraunhofer Institute for Technological Trend Analysis INT. Bonn, Germany: Behörden Spiegel Group, 2020, pp. 46–47

Freudendahl, Diana; Langner, Ramona; Brandt, Heike:
Material trends: Bio-based additive for sustainable plastics
In: Werkstoffe in der Fertigung [Materials in Manufacturing], (2020), No. 3, pp. 3

Freudendahl, Diana; Brandt, Heike; Langner, Ramona:
Material trends: Boron compounds with ultrahigh thermal conductivity
In: Werkstoffe in der Fertigung [Materials in Manufacturing], (2020), No. 4, pp. 3

Grigoleit, Sonja; Desideri, Lorenzo (Contributor); Andreou, Andreas (Contributor); Mavromoustakis, Constandinos X. (Contributor); Maguire, Rebecca (Contributor); Cooke, Michael (Contributor); Desmond, Deirdre (Contributor); O'Sullivan, Ronan (Contributor); Müller, Olaf (Contributor); Franke, Philip (Contributor); Brehm, Judith (Contributor); Zurkuhlen, Alexia (Contributor); Scott, Michael (Contributor); Silva, Anabela G. (Contributor); Ribeiro, Óscar (Contributor); Santinha, Gonçalo (Contributor); Paúl, Constança (Contributor); Costa, Elísio (Contributor); Rocha, Pedro (Contributor); Silva, Renato (Contributor); Teles de Sousa, Soraia (Contributor); Villacañas, Óscar (Contributor); Moreno, Evelyn (Contributor); Ojanguren, Karina (Contributor); Carretero, Maite (Contributor); del Toro Garcia, Xavi (Contributor); Santofimia Romero, Maria José (Contributor); Stamatiadis, Vagelis (Contributor); Gioulekas, Fotios (Contributor); Gütter, Zdenek (Contributor); Stybnar, Michal (Contributor); Pesoutová, Markéta (Contributor); :
Deliverable D6.1 - SHAPES Pan-European Pilot Campaign Plan
Euskirchen, Germany, 2020
URN urn:nbn:de:0011-n-6217681

Hansen-Casteel, Stephanie; Lauster, Michael (assessor); Schraudner, Martina (assessor):
Indicator-based model for the prospective assessment of technology acceptance: Dissertation for obtaining the academic degree of Doctor of Natural Sciences, approved by the Faculty of Mechanical Engineering of the RWTH Aachen University
Aachen, Univ., Diss., 2020
DOI 10.18154/RWTH-2020-04872

Heuer, Carsten; Kohlhoff, Jürgen:
Artificial muscles
In: Europäische Sicherheit & Technik [European Safety and Technology]: ES & T, Vol. 69 (2020), No. 10, pp. 35

Höffgen, Stefan; Metzger, Stefan; Steffens, Michael:
Investigating the effects of cosmic rays on space electronics
In: Frontiers in Physics, Vol. 8 (2020), Art. 318, 9 pp.
DOI 10.3389/fphy.2020.00318 URN
urn:nbn:de:0011-n-6031005

Höffgen, Stefan:
Single event effects, a threat in space and on Earth: Dr. Stefan Höffgen, Scientist, Nuclear Effects in Electronics and Optics business unit, Fraunhofer INT
In: Proll, R. Uwe (ed.): AFCEA 2020. Fraunhofer Institute for Technological Trend Analysis INT. Bonn, Germany: Behörden Spiegel Group, 2020, pp. 51–52

Hollmann, Vanessa:
Bioinspired sensors
In: Europäische Sicherheit & Technik [European Safety and Technology]: ES & T, Vol. 69 (2020), No. 6, pp. 70
URN urn:nbn:de:0011-n-5931548

Huppertz, Guido:
Multi-Domain UxS
In: Europäische Sicherheit & Technik [European Safety and Technology]: ES & T, Vol. 69 (2020), No. 2, pp. 79
URN urn:nbn:de:0011-n-6182685

Hurtig, Tomas; Pusch, Thorsten; Schaarschmidt, Martin; Elfsberg, Mattias; Wellander, Niklas; Suhrke, Michael:
A reference test setup and comparison between different HPEM testing schemes
(International Symposium on Electromagnetic Compatibility (EMC Europe) <2020, online>)
In: Institute of Electrical and Electronics Engineers (IEEE): International Symposium on Electromagnetic Compatibility — EMC EUROPE 2020. Proceedings: September 23–25, 2020, virtual conference. Piscataway, New Jersey, USA: IEEE, 2020, Paper 344, 5 pp.
DOI 10.1109/EMCEUROPE48519.2020.9245826

John, Marcus:
KATI — Are you still searching, or are you already conducting analysis?: Dr. Marcus John, KATI — Knowledge Analytics for Technology & Innovation Project Manager, Fraunhofer INT
In: Proll, R. Uwe (ed.): AFCEA 2020. Fraunhofer Institute for Technological Trend Analysis INT. Bonn, Germany: Behörden Spiegel Group, 2020, pp. 42–43

Kohlhoff, Jürgen:
DNA data storage
In: Europäische Sicherheit & Technik [European Safety and Technology]: ES & T, Vol. 69 (2020), No. 3, pp. 88
URN urn:nbn:de:0011-n-5829673

Lahaye, Sébastien; Sakkas, George; Tsaloukidis, John; Salvi, Olivier; Walther, Gerald; Neisser, Florian; Mrosek, Karin; Zawistowski, Grzegorz; Fellner, Radoslaw:
Deliverable D3.6 - Final Strategic Research and Standardisation Agenda #2
Brussels: European Commission, 2020
URN urn:nbn:de:0011-n-6158418

Langner, Ramona:
Machine learning in material development
In: Europäische Sicherheit & Technik [European Safety and Technology]: ES & T, Vol. 69 (2020), No. 12, pp. 109

Langner, Ramona; Brandt, Heike; Freudendahl, Diana:
Material trends: Machine learning in material development
In: Werkstoffe in der Fertigung [Materials in Manufacturing], (2020), No. 5, pp. 3

Lanzrath, Marian:
Drone defense using high power electromagnetics (HPEM): Marian Lanzrath, Scientist, Electromagnetic Effects and Threats business unit, Fraunhofer INT
In: Proll, R. Uwe (ed.): AFCEA 2020. Fraunhofer Institute for Technological Trend Analysis INT. Bonn, Germany: Behörden Spiegel Group, 2020, pp. 44–45

Lanzrath, Marian; Suhrke, Michael; Hirsch, Holger:
HPEM-based risk assessment of substations enabled for the smart grid
In: IEEE transactions on electromagnetic compatibility, Vol.62 (2020), No.1, pp.173-185
DOI 10.1109/TEMC.2019.2893937

Lanzrath, Marian; Hirsch, Holger (Gutachter); Garbe, Heyno (Gutachter) :
Vulnerability of the smart grid to HPEM
Accredited by: Duisburg-Essen, Univ., Diss., 2020
DOI 10.17185/duepublico/72372

Lauster, Michael:
This crisis will be followed by other crises: Prof. Michael Lauster, Head of the Fraunhofer Institute for Technological Trend Analysis INT, Euskirchen, Germany
In: Behörden Spiegel Newsletter, Verteidigung, Streitkräfte und Politik [Defense, armed forces and politics], 2020, No. 262, pp. 2

Lauster, Michael:
Future narratives — narrating future research practices
In: Breitenwischer, Dustin (ed.): Faktuales und fiktionales Erzählen II: Geschichte - Medien - Praktiken [Factual and fictional tales II: history, media, practices]. Baden-Baden, Germany: Ergon Verlag, 2020. (Faktuales und fiktionales Erzählen 8 [Factual and fictional narratives]), pp. 225–238
DOI 10.5771/9783956505126-225

Loosen, Thomas (ed.); Haberlach, Angela (ed.); Frederick, Gina (ed.); Makome, Angelique (ed.); Büttgen, Jan-Lukas (ed.); Fraunhofer Institute for Technological Trend Analysis INT, Euskirchen, Germany:
Fraunhofer Institute for Technological Trend Analysis INT. Annual Report 2019
Euskirchen, Germany: Fraunhofer INT, 2020
URN urn:nbn:de:0011-n-5931956

Lubkowski, Grzegorz; Lanzrath, Marian; Cesbron Lavau, Louis; Suhrke, Michael:
Response of the UAV sensor system to HPEM attacks
(International Symposium on Electromagnetic Compatibility (EMC Europe) <2020, online>)
In: Institute of Electrical and Electronics Engineers (IEEE): International Symposium on Electromagnetic Compatibility — EMC EUROPE 2020. Proceedings: September 23–25, 2020, virtual conference. Piscataway, New Jersey, USA: IEEE, 2020, Paper 217, 6 pp.
DOI 10.1109/EMCEUROPE48519.2020.9245834

Metzger, Stefan:
Nuclear and electromagnetic effects: Dr. Stefan Metzger, Head of the Nuclear and Electromagnetic Effects department, Fraunhofer INT
In: Proll, R. Uwe (ed.): AFCEA 2020. Fraunhofer Institute for Technological Trend Analysis INT. Bonn, Germany: Behörden Spiegel Group, 2020, pp. 39–40

Müller, Larissa; Sendrowski, Philip; Sturm, Peter; Kaluza, Benjamin:
Customized technology solutions for rural areas
In: Schroth, Fabian (ed.) et al.: Horizonte erweitern - Perspektiven ändern: Ländliche Räume als Innovationsräume verstehen und fördern. [Widening horizons — changing perspectives: understanding and facilitating rural areas to become areas of innovation]. Stuttgart, Germany: Fraunhofer IAO, 2020, pp. 68–79

Neisser, Florian; Berchtold, Claudia; Kaluza, Benjamin:
Governance challenges in changing environments. Cross-organizational and multi-national wildfire risk management: Presentation held at 11th International Sustainability Transition Conference 2020, August 18–21, 2020, online event
(International Sustainability Transition Conference (IST) <11, 2020, online>)
2020
URN urn:nbn:de:0011-n-6059142

Neupert, Ulrik; Pastuszka, Hans-Martin:
Technology foresight to support long-term R&T planning: Dr. Ulrik Neupert, Scientist, Defense Technology Foresight business unit, Fraunhofer INT / Hans-Martin Pastuszka, Head of the Defense Technology Foresight business unit, Fraunhofer INT
In: Proll, R. Uwe (ed.): AFCEA 2020. Fraunhofer Institute for Technological Trend Analysis INT. Bonn, Germany: Behörden Spiegel Group, 2020, pp. 48–50

Offenberg, David:
Lidar-on-a-chip
In: Europäische Sicherheit & Technik [European Safety and Technology]: ES & T, Vol. 69 (2020), No. 5, pp. 89
URN urn:nbn:de:0011-n-5895828

Offenberg, David:
Metalenses
In: Europäische Sicherheit & Technik [European Safety and Technology]: ES & T, Vol. 69 (2020), No. 11, pp. 49

Offenberg, David; Langner, Ramona; Freudendahl, Diana:
Material trends: Direct solar hydrogen production
In: Werkstoffe in der Fertigung [Materials in Manufacturing], (2020), No. 6, pp. 3

Offenberg, David; Langner, Ramona; Freudendahl, Diana:
Material trends: Metalenses
In: Werkstoffe in der Fertigung [Materials in Manufacturing], (2020), No. 1, pp. 3

Pinzger, Britta; Römer, Silke:
Analysis of the international defense technology research and technology to support long-term R&T planning
In: German Federal Ministry of Defense (BMVg), Bonn: Military science research. Annual Report 2019. Bonn, Germany: BMVg, 2020, pp. 26–27

Pinzger, Britta:
Living sensors
In: Europäische Sicherheit & Technik [European Safety and Technology]: ES & T, Vol. 69 (2020), No. 8, pp. 77
URN urn:nbn:de:0011-n-5993976

Porer, Michael; Rettig, Laurenz; Bothschafter, Elisabeth Monika; Esposito, Vincent; Versteeg, Rolf B.; Loosdrecht, Paul H.M. van; Savoini, Matteo; Rittmann, Jochen; Kubli, Martin; Lantz, Gabriel; Schumann, Olaf Jochen; Nugroho, Agustinus Agung; Braden, Markus; Ingold, Gerhard; Johnson, Steven L.; Beaud, Paul; Staub, Urs:
Correlations between electronic order and structural distortions and their ultrafast dynamics in the single-layer manganite Pr0.5Ca1.5MnO4
In: Physical Review. B, Vol. 101 (2020), No. 7, Art. 075119, 9 pp.
DOI 10.1103/PhysRevB.101.075119

Pusch, Thorsten R.; Suhrke, Michael; Jörres, Benjamin:
Characterization of a reference test setup for the development of HPEM standards
In: IEEE letters on electromagnetic compatibility practice and applications : L-EMCPA, (2020), Online First, 4 pp.

Pusch, Thorsten; Suhrke, Michael; Jörres, Benjamin:
Description of a reference test setup for the development of HPEM standards
(International Exhibition and Conference on Electromagnetic Compatibility (EMC) <2020, online>)
In: International Exhibition and Conference on Electromagnetic Compatibility, EMC 2020. Stuttgart, Germany: Mesago Messe Frankfurt, 2020, pp. 89–96

Pusch, Thorsten; Suhrke, Michael; Schaarschmidt, Martin:
Reference test setup for the development of HPEM standards
In: German Federal Ministry of Defense (BMVg), Bonn: Military science research. Annual Report 2019. Bonn, Germany: BMVg, 2020, pp. 24–25

Risse, Monika; Glabian, Jeannette; Köble, Theo:
Qualification measurements of handheld radiation detectors for homeland security purposes: Paper presented at INMM 2020, 61st Annual Meeting Institute of Nuclear Materials Management, July 12-16, 2020, Virtual Event
(Institute of Nuclear Materials Management (INMM Annual Meeting) <61, 2020, online>)
2020

Ruhlig, Klaus:
Adversarial machine learning
In: Europäische Sicherheit & Technik [European Safety and Technology]: ES & T, Vol. 69 (2020), No. 9, pp. 102

Schroth, Fabian; Last, Gesine; Müller, Larissa; Sendrowski, Philip:
Designing the future
In: LandInForm, (2020), No. 2, pp. 44–45

Schulze, Joachim; Grüne, Matthias; John, Marcus; Neupert, Ulrik; Thorleuchter, Dirk:
Futures research as an opportunity for innovation in verification technologies
In: Niemeyer, Irmgard (editor): Nuclear non-proliferation and arms control verification: Innovative systems concepts. Cham: Springer International Publishing, 2020, pp. 187-204
DOI 10.1007/978-3-030-29537-0_13

Silva, Anabela G.; Rocha, Nelson; Almeida, Margarida; Silva, Telmo; Ribeiro, Óscar; Santinha, Gonçalo; Tavares, Rita; Andreou, Andreas (Contributor); Mavromoustakis, Constandinos X. (Contributor); Guerra, Bárbara (Contributor); D'Arino, Lucia (Contributor); Pérez, Óscar (Contributor); Isaris, Paul (Contributor); Cooper, Sara (Contributor); Berchtold, Claudia (Contributor); Silva, Tatiana (Contributor):
Deliverable D5.1 - SHAPES user experience design and guidelines
Aveiro/Portugal, 2020
URN urn:nbn:de:0011-n-6216813

Sturm, Flavius; Pott, Christoph:
Open Strategy in a Research Organization: Joint Exploration of Research Opportunities in Logistics IT
(International Conference on Engineering, Technology and Innovation (ICE) <26, 2020, Online>)
In: Institute of Electrical and Electronics Engineers -IEEE-: IEEE International Conference on Engineering, Technology and Innovation, ICE/ITMC 2020. Proceedings: Virtual Conference, 15 - 17 June 2020. Piscataway, NJ: IEEE, 2020, 9 pp.
DOI 10.1109/ICE/ITMC49519.2020.9198644

Sturm, Peter:
On-Orbit Servicing
In: Europäische Sicherheit & Technik [European Safety and Technology]: ES & T, Vol. 69 (2020), No. 1, pp. 64
URN urn:nbn:de:0011-n-5725490

Sulcek, Lara; Langner, Ramona; Werner-Zwanziger, Ulrike; Zwanziger, Josef W.; Martineau-Corcos, Charlotte; Fechtelkord, Michael:
Solid-state nuclear magnetic resonance investigation of synthetic phlogopite and lepidolite samples
In: Magnetic resonance in chemistry, Vol.58 (2020), No.11, pp.1099-1108
DOI 10.1002/mrc.4998

Trinkl, Moritz; Kaluza, Benjamin F.; Wallace, Helen; Heard, Tim A.; Keller, Alexander; Leonhardt, Sara D.:
Floral species richness correlates with changes in the nutritional quality of larval diets in a stingless bee
In: Insects, Vol.11 (2020), No.2, Art. 125, 19 pp.
DOI 10.3390/insects11020125

Wilson, Rachele S.; Leonhardt, Sara D.; Burwell, Chris J.; Fuller, Chris; Smith, Tobias J.; Kaluza, Benjamin F.; Wallace, Helen M.:
Landscape simplification modifies trap-nesting bee and wasp communities in the subtropics
In: Insects, Vol.11 (2020), No.12, Art. 853, 16 pp.
DOI 10.3390/insects11120853

Yildirim, Baycan:
Predictive maintenance
In: Europäische Sicherheit & Technik: ES & T, Vol.69 (2020), No.4, pp.83
URN urn:nbn:de:0011-n-5864994

Other reports

Walther, G., Neisser, F., Sakkas, G., Vassiliki, V., Kazantzidou-Firtinidou, D.; Papathanasiou, C., Gkotsis, I., Sadowska, J. & G. Zawistowski:
FIRE-IN Deliverable D2.3 RDI and standardisation screening report. (unpublished)

Personalia

Bornhöft, M. C.:
»Digital Pulse Processing Methods for Simultaneous Efficient Detection and Identification of Neutron and Gamma Radiation of Novel Detection Materials« doctorate, RWTH Aachen University, 2016-ongoing

Lanzrath, M.:
»HPEM-Verwundbarkeit moderner Energieversorgungssysteme« doctorate, University of Duisburg-Essen, 2015-2020, date of oral exam: July 2, 2020

Cesbron Lavau, L.:
»IEMI and Information Security« doctorate, RWTH Aachen University, 2019-ongoing

Arduini Ribeiro, F.:
»EMI Risk Management on the scale of the Smart Grid as a network of systems« doctorate, Leibniz University Hanover, 2020-ongoing

Vollmer, M.:
»Implementing innovations in disaster management to increase resilience – laws, policies, and organizational determinants«, University of Wuppertal, 2016–ongoing (submitted)

Wölk, D.:
»Untersuchung und Entwicklung von Analysemethoden zu neutroneninduzierten SEE« doctorate, University of Cologne, 2017-ongoing

Other events

January 14/15, 2020
Fraunhofer Group for Defense and Security VVS: Preparation workshop at the third Future R&T Situation Conference of the BMVg, Fraunhofer INT, Euskirchen, Germany

February 06, 2020
Workshop with the BMVg and German Federal Armed Forces on the 2019-3 and 2019-4 editions of the Defense Technologies Forecast (WTV), Fraunhofer INT, Euskirchen, Germany

February 12/13, 2020
3. Future R&T Situation Conference of the BMVg, R&T Director of the BMVg with Fraunhofer INT at Fraunhofer INT, Euskirchen, Germany

June 15-18, 2020
NEPP Electronics Technology Workshop (ETW)

October 6-8, 2020
SEEMAPLD

October 19 - November 20, 2020
RADECS

Novmeber 02/03, 2020
Fraunhofer Group for Defense and Security VVS: Fraunhofer News 2020 »Digitalization in the battlefield — requirements for the future viability of the German Federal Armed Forces", German Federal Armed Forces Office for Defense Planning, online

December 1-8, 2020
NSREC

December 03, 2020
Workshop with the BMVg and German Federal Armed Forces on identifying themes for the 2021/22 edition of the Defense Technologies Forecast (WTV), Fraunhofer INT, online

December 9-10, 2020
G-RAD

Press releases

»3. Zukunftslagekonferenz Forschung und Technologie des BMVg – Fernlicht auf technologisches Innovationspotenzial für die Streitkräfte«
February 14, 2020

»Research*EU Magazine wählt EU-Projekt IN-PREP zum Projekt des Monats«
August 20, 2020

»EU-Projekt SHAPES wird auf die Herausforderungen von globalen Pandemien wie COVID-19 angepasst «
August 28, 2020

»Fraunhofer vs. COVID-19«: Start von Fraunhofer-Gemeinschaftsprojekt KResCo
November 25, 2020

Institute seminars

Vollmer, M. (Fraunhofer INT):
»SmartResilience und ResiStand – erste abgeschlossene Projekte zum Thema Resilienz«, Euskirchen, Germany, January 22, 2020

Gabel, O. (Fraunhofer INT):
»Newtons Apfel in der gekrümmten Raumzeit – Von Grundkonzepten der Relativitätstheorie zur Beschreibung frei fallender Experimente mithilfe von Krümmungsentwicklungen um Einsteins Äquivalenzprinzip«, Euskirchen, Germany, January 29, 2020

Riebe, T. (Technical University Darmstadt):
»Dual-use of Concern in ICT: Artificial Intelligence and Social Media Cases as well as Methods of Assessment«, Euskirchen, Germany, February 5, 2020

Kaufhold, M.-A. (Technical University Darmstadt):
»Artificial Intelligence and Usable Interfaces for Social Media Analytics: Current Approaches and Challenges in the Domain of Crisis Informatics«, Euskirchen, Germany, February 5, 2020

Dietz, A. (Fraunhofer IST):
»In Situ Resource Utilization auf dem Mond«, Euskirchen, Germany, February 19, 2020

Müller, L., Sendrowski, P., Sturm, P. (Fraunhofer INT):
Das Projekt »Horizonte erweitern«, Euskirchen, Germany, March 11, 2020

Suhrke, M. (Fraunhofer INT):
»Geschäftsfeld Elektromagnetische Effekte und Bedrohungen – Aktuelle Projekte« Euskirchen, Germany, November 18, 2020

John, M. (Fraunhofer INT):
»Where do we go tomorrow? »Data Driven Foresight«, KATI und wie das alles zusammen passt«, Euskirchen, Germany, November 25, 2020

Kuhnhenn, J. (Fraunhofer INT):
»Elon Musk und das INT: Wie NewSpace NEO verändert«, Euskirchen, Germany, December 2, 2020

Grigoleit, S. (Fraunhofer INT):
»Das neue EU-Projekt SHAPES "Smart and healthy ageing«, Euskirchen, Germany, December 9, 2020

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By air

Nearest airports:

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

By rail

Nearest Inter-City Main Stations:

- Bonn Hauptbahnhof.
- Köln Hauptbahnhof.

From there regular rail connections to Euskirchen.
From Euskirchen Station with Bus No 875 in direction »Großbüllesheim-Wüschheim«; or Bus No 806 in direction »Heimerzheim Fronhof« to »Appelsgarten«

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