Fraunhofer
MEVIS

FRAUNHOFER INSTITUTE FOR DIGITAL MEDICINE

ANNUAL REPORT 2019

FRAUNHOFER MEVIS

INSTITUTE FOR DIGITAL MEDICINE

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Digital Medicine, Arts, and STEAM: BEFORE US LIES ETERNERDY, by Fraunhofer MEVIS in cooperation with artists Ina Conradi and Mark Chavez from Media Art Nexus (MAN) at Nanyang Technological University Singapore. A 2D edit of the artistic, large-scale immersive experience was recognized by the scientific documentary industry and won the Industry Award for Best Infographic at Raw Science Film Festival 2019 held in Los Angeles, USA. The sciart installation shows different scales of the human body, from digitized microscopic lymphoma tissue examined with the molecular cytogenetic technique Fluorescent in situ hybridization (FISH) to detect abnormal changes in DNA, to 3D reconstructions of two vessel systems of a liver as well as a whole-body MRI. It launched in the Deep Space 8K at the Ars Electronica Center in Linz, Austria, and simultaneously at the MAN in Singapore in 2018. Image Copyright: Quek Jia Liang

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FRAUNHOFER MEVIS AT A GLANCE

BRIEF PROFILE

The mission of Fraunhofer MEVIS is to overcome the complexity in medicine and to pave the way towards a digital medicine that is more efficient and reliable, with higher success rates and reduced side effects. We are bridging between integrated diagnosis, intelligent interventions, multimodal imaging, and digitally encoded medical knowledge. Working closely together with our clinical, academic, and industrial partners worldwide, we strive to solve the complexity of healthcare and translate feasibility into availability to overcome the innovation gap[1].

Strategic Considerations

The roots of Fraunhofer MEVIS lie in the creation, quantitative analysis, and interactive exploration of medical image data in their specific clinical context. We believe that medical imaging shall no longer be regarded as a field on its own. Instead, image features must be quantitatively correlated to available clinical information in order to discover new relevant knowledge. Fraunhofer MEVIS is uniquely positioned by combining a deep understanding of clinical procedures and problems with a mastering of the technological value chain – from imaging physics and data generation to algorithm and platform development to validation, product certification, and clinical implementation. Two main strategic target areas are guiding our actions: *»integrated clinical decision support«* and *»intelligent minimally-invasive interventions«*.

We have built substantial expertise and a good reputation in the deep learning and artificial intelligence (AI) arena. This enables us to successfully cope whith the rapidly growing complexity in all diagnostic and therapeutic domains. While many groups worldwide are active in the field of medical AI, Fraunhofer MEVIS is one in a few that covers the complete process of knowledge generation such that AI will eventually become a powerful clinical tool in hospitals and medical practices. Solutions based on our collaborative and modular software platforms are used likewise in multi-centric clinical trials and pharmaceutical research. Below, we briefly describe the building blocks needed to fulfill our mission.

1 cf. chart on page 9

Clinical Commitment

Research and development at Fraunhofer MEVIS is guided by a clinical direction instead of being technologically or methodologically driven. Our work focuses on developing innovative solutions for computer-assisted medical processes and their industrial implementation for clinical use. Identifying and analyzing clinical issues demands a deep understanding of medical research and calls for close cooperation with our partners. Fraunhofer MEVIS maintains an international network of over 100 clinical partners. This clinical network is an essential source to understand user needs and to evaluate the potential clinical value and feasibility of developed solutions.

Industrial Collaboration

True innovation, the successful launch of solutions onto the market with tangible impact, is only possible through close collaboration with industrial partners with the necessary resources and market know-how to fuel the development of new technologies. Fraunhofer MEVIS functions as the link between clinicians and industry, aiming at technological advancement for clinical use. Transferring applied research to the industry is a pillar of the institute and a basis for future research. Partners for cooperation and clients for industrial research and development include large firms and small- or medium-sized ventures in medical technology, pharmaceutics, and related fields.

Certification

Successful introduction of innovative approaches onto the market requires adherence to specific regulations, such as the German Act on Medical Devices (MPG) or the approval guidelines of the United States Food and Drug Administration (FDA). Fraunhofer MEVIS is one of a small group of medtech research facilities worldwide that, in Bremen since 2005 and in Lübeck since 2012, has operated a quality management system according to the EN ISO 13485 (Medical Devices) standard with a special focus on implementing a software development

process in compliance with IEC 62304. The establishment of these quality management systems with the scope on design, development and production of software for medical products lays out well-defined steps for industrial cooperation and enables Fraunhofer MEVIS to provide market-ready solutions for commercial partners in the strongly regulated medical device market. In addition, Fraunhofer MEVIS also has experience with CE and FDA approval of software solutions for clinical environments.

Software Platform

Fraunhofer MEVIS has initiated and developed a family of versatile, modular web-enabled software platforms that enable our partners and ourselves to build new solutions faster and to better adapt to new challenges. The MeVisLab development platform by Fraunhofer MEVIS and MeVis Medical Solutions AG is a tool for rapid prototyping, flexible development of clinical software solutions as well as developing products and methods for fields such as image analysis, visualization, and biophysical modeling. The joint use of MeVisLab at Fraunhofer MEVIS and partners in research, medicine, and industry promotes synergy and accelerates development. This supports the tight technological integration of clinics, research, and industry. MeVisLab provides a modular interface to 3D Slicer, a software platform for the analysis and visualization of medical images and for research in image-guided therapy. Slicer is a free, open source software available on multiple operating systems and extensible via plugins for adding algorithms and applications. Moreover, Fraunhofer MEVIS has developed the remote deep learning framework RedLeaf as an extension of MeVisLab, that allows for modular, distributed and reproducible pattern recognition on large medical datasets.

Three additional platforms target specific application areas, with Histokat Web serving at multicentric research, development and validation of solutions in the field of computational pathology, and our deformable image registration library RegLib is used for multimodality, intraoperative, and follow-up image matching and motion correction. Our modular software platform QuantMed supports quantitative medicine to enable more reliable, accurate, and efficient clinical decisions. QuantMed offers support along the way: creating reference training data, training and validating deep learning models, and deploying the results into your quantitative diagnostic software.

Business Areas

Our four business areas align with our strategic directions as described above and focus on specific market segments and related industrial customers. A range of services and solutions can therefore be tailored and developed for these customer groups.

The planning and support of surgical and minimally invasive procedures, which has been a key focus of Fraunhofer MEVIS since its founding, is developed in the business area *»Image-Guided Therapy«*. A particular challenge here is to provide the operating physician all relevant information at the time he/she needs it. Customers are mainly hardware vendors that span a wide range of products from implants like valves and stents to catheters and needles, treatment devices like robots, focused ultrasound systems or linear accelerators (linacs), as well as navigation devices.

The business area *»Diagnostic Software«* is centered around the clinical challenge to ensure optimal therapeutic decisions and improved early detection, incorporating the constantly growing amount of multidisciplinary data on the one hand and the efficiency pressure for faster processing on the other. The customers in this segment are imaging device vendors, clinical IT companies, and specialized image analysis providers.

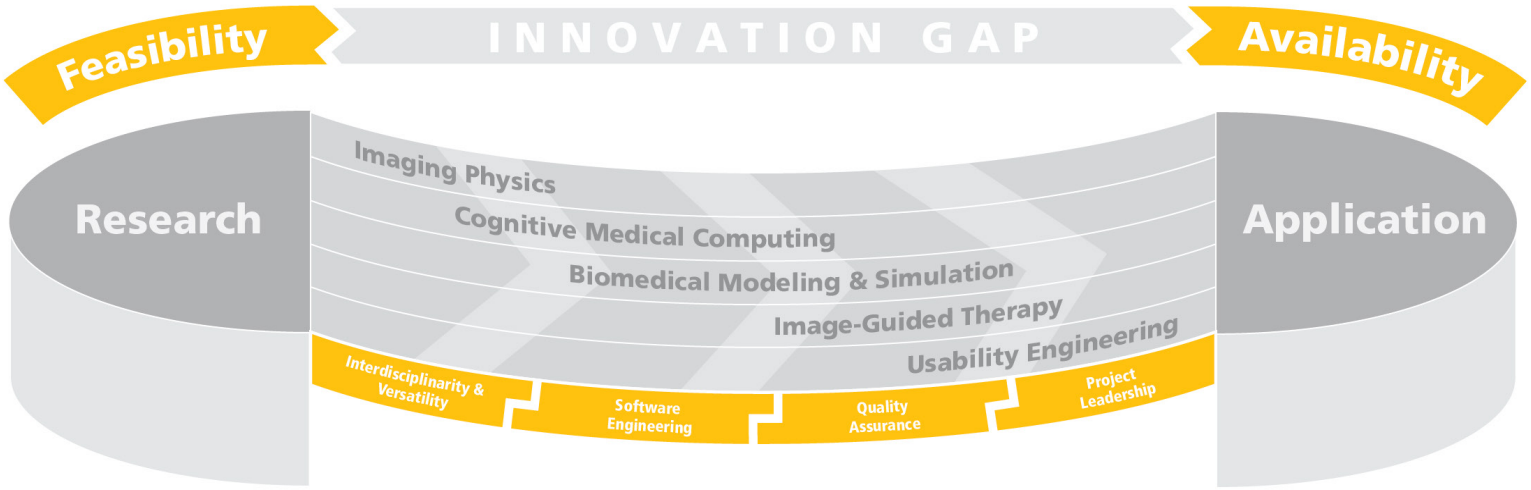
Within the area of diagnostic software, we have defined a specific business area around *»Computational Pathology«* as a field with special potential for growth, considerable technological development, and not least for becoming a game-changer in the field of precision medicine due to the enormous amount of information encoded in the digitized tissue sections. Customers are manufacturers and providers of digital pathology equipment, biotech companies, laboratories, as well as healthcare IT integrators. Our key focus is in modular pattern analysis and virtual multi-staining based on highly accurate deformable im-

Fraunhofer MEVIS – Partner in Translation

FROM FEASIBILITY TO AVAILABILITY

Research worldwide generates novel solution concepts, algorithms, and ideas with great innovation potential. These concepts demonstrate feasibility, but only a very small number reach actual clinical use.

To make novel ideas and concepts available in the clinical routine, the innovation gap must be bridged. Fraunhofer MEVIS is a key partner in this complex translational process.



Interdisciplinarity & Versatility

Fraunhofer MEVIS has a deep understanding of medical needs, academic research, and industrial challenges, the three key areas of innovation.

Software Engineering

Professional software development teams at Fraunhofer MEVIS offer short innovation cycles based on MeVisLab, RegLib, and Histology Toolkit, rapid prototyping and productization platforms.

Quality Assurance

Fraunhofer MEVIS's expertise in quality management and regulatory processes, including stringent testing and documentation, brings prototypes closer to becoming certified medical products.

Project Leadership

The project management competence at Fraunhofer MEVIS is a crucial ingredient to successful interdisciplinary and international research collaborations.

age registration, thereby building on existing digital pathology platforms.

The business area »*Clinical Trials and Pharma*« emerged from the field of analysis software for image-based studies, combined with our web-based software platform developments, and is being expanded to a comprehensive range of services for the industry and for larger research consortia. Customers are pharmaceutical companies, contract research organizations (CROs), service and software providers for image analysis as well as researchers in hospitals, laboratories, and industry.

Additional business activities open up the potential for exploitation of the existing expertise in the field of imaging physics. We aim at bundling the offers of other areas of competence for the customer group of medical imaging device manufacturers. In magnetic resonance imaging (MRI), we offer our expertise to develop dedicated sequences for research, clinical and commercial customers.

Technology and Translation

The following scientific and supporting core competences form the pillars of our work in research, technology, and translation.

The process of creating medical images is addressed by our core competence »*Imaging Physics*«. This spans from improving image acquisition and creating new physiological information to automated motion tracking and quality assessment. The goal is to integrate image acquisition and post-processing to an optimized image analysis pipeline. Since April 2011, Fraunhofer MEVIS is operating an on own 3 Tesla MRI scanner for research and clinical studies.

The core competences »*Cognitive Medical Computing*« and »*Clinical Decision Support*« revolve around the extraction of information from medical images and other medical data. The previous technological focus of image processing has been extended to non-imaging data and, therefore, to the challenge of incorporating a broad range of relevant clinical information. The main goals are to maintain and expand our competence in the automatic extraction of quantitative information in imaging and other big data scenarios and in efficient interactive solutions for decision support systems as well as for planning and support systems in image-guided therapy. In this context, data-driven approaches such as machine learning, especially deep learning, are becoming increasingly important. At Fraunhofer MEVIS, machine learning is successfully applied for image segmentation as well as tissue and cell classification, among other things.

With our core competence »*Image Registration*« we aim at harmonizing images from different modalities, capture times, or patients, in order to evaluate the combined information. Fraunhofer MEVIS provides applicable image registration with a focus on robust, reasonable, accurate, and computationally highly efficient solutions.

Our core competence »*Modeling and Simulation*« enables us to incorporate knowledge of biophysical and biomedical processes to enhance the information within medical images. In addition to application driven developments, we perform basic research to enhance the technological capabilities. A particular focus for the next years will lie on validation of simulation results, in order to gain acceptance by industrial partners and physicians.

The capability of providing high quality, modular, reusable software components, efficient and well-integrated software applications and flexible deployment is developed and encapsulated in the core competence »*Custom Software Solutions*«.

The anchoring of Fraunhofer MEVIS in digital medical technology and the focus of its research activities towards clinical benefits are strengthened through the core competence »*Clinical Expertise*« and will be further developed as a long term USP.

A goal of our »*Science Communication*« is to create projects, exhibits, movies and workshops in which scientists contextualize their expertise and research in a broader sense and become inspired to relate facts, empirical data, and science to humanities, social realities, and values.

Links to Academic Institutions

In addition to the network of clinical partners, Fraunhofer MEVIS maintains a strong network of technological and aca-

demic partners. In 2019, Fraunhofer MEVIS is connected with eight universities in Germany, the Netherlands, and the United States through twelve professorships:

- University of Bremen: Prof. Kikinis, Prof. Günther
- Jacobs University Bremen: Prof. Hahn, Prof. Preusser
- University of Applied Sciences Bremerhaven: Prof. Rascher-Friesenhausen
- University of Lübeck: Prof. Modersitzki
- Charité, TU Berlin: Prof. Hennemuth
- RWTH Aachen: Prof. Kiessling, Prof. Merhof, Prof. Schulz
- Radboud University Nijmegen: Prof. van Ginneken
- Harvard Medical School, Brigham and Women's Hospital: Prof. Kikinis

From its first days, Fraunhofer MEVIS maintains strong ties to the universities in the State of Bremen. The directors of the institute hold professorships at the University of Bremen and the Jacobs University Bremen. Further close cooperation exists through professorships in the fields Imaging Physics, Modeling and Simulation, and Medical Technology. The University of Bremen and Fraunhofer MEVIS intensified their partnership in computer science education through a new study focus Medical Computing starting in winter semester 2018/19.

With financial support of the State of Schleswig-Holstein and the European Union, the Fraunhofer MEVIS Project Group for Image Registration was established at the University of Lübeck in April 2010. The internationally renowned group addresses the core competence of state-of-the-art medical image registration in close cooperation with the Institute of Mathematics and Image Computing (MIC) at the University of Lübeck. Since July 2015, the project group is part of the Fraunhofer MEVIS mother institute in Bremen.

Since 2012, Fraunhofer MEVIS pursues a strategic partnership with the Diagnostic Image Analysis Group (DIAG) at the Radboud University Medical Center in Nijmegen, the Netherlands, an internationally renowned center of excellence for Computer-Aided Diagnosis (CAD).

In April 2017, Fraunhofer MEVIS opened a new site in Berlin with close links to the German Heart Center, the Charité – Universitätsmedizin, and the Technical University Berlin. Fraunhofer MEVIS researcher Anja Hennemuth was appointed professor for image-based therapy support at the Institute for Imaging Science and Computational Modelling in Cardiovascular Medicine.

In 2018 Fraunhofer MEVIS established a strategic cooperation with the Institute of Experimental Molecular Imaging (ExMI) at the RWTH Aachen headed by Prof. Fabian Kiessling. In close collaboration with the Comprehensive Diagnostic Center Aachen (CDCA), particular attention is paid to projects in the field of OMICS data. This includes the development of automated and standardized workflows for the detection, segmentation, and extraction of biomarkers in the fields of radiomics and quantitative pathology.

Own Building and New Name

In September 2016 started the planning and in September 2018 the construction of an own building for Fraunhofer MEVIS located on the campus of the University of Bremen. The new institute building is funded in equal parts by the Federal Republic of Germany, the Federal State of Bremen, and the European Commission. It is planned to be ready in spring 2021.

Exactly ten years after joining the Fraunhofer-Gesellschaft, on January 1, 2019, the former Fraunhofer Institute for Medical Image Computing MEVIS changed its official name to Fraunhofer Institute for Digital Medicine MEVIS (Fraunhofer-Institut für Digitale Medizin MEVIS). The new name, in short still Fraunhofer MEVIS, underscores the institute's mission to drive the transformation of tomorrow's digital, integrated precision medicine through systematic computer support.

Brief History

The current Fraunhofer MEVIS institute was founded in August 1995 as MeVis – Center for Medical Diagnostic Systems and Visualization, a non-profit limited liability company (gGmbH) at the University of Bremen. The founder Prof. Dr. Heinz-Otto Peitgen was appointed executive director, and an international scientific advisory board oversaw research. To expand the in-

stitute scientifically and economically, MeVis received a fixed basic funding from the State of Bremen. In 2006, the institute was renamed MeVis Research GmbH, Center for Medical Image Computing.

Since 1997, MeVis Research has produced several legally and financially independent spin-offs that were consolidated in 2007 into MeVis Medical Solutions AG, a publicly traded company that employs about 150 people. Aside from a few temporary declines in staff due to changes in personnel caused by the founding of a new company, the number of employees of MeVis Research increased steadily from 10 to 51 full-time positions by the end of 2008.

On January 1, 2009, MeVis Research was incorporated into the Fraunhofer-Gesellschaft and renamed Fraunhofer Institute for Medical Image Computing MEVIS (Fraunhofer-Institut für Bildgestützte Medizin MEVIS). Prof. Dr. Heinz-Otto Peitgen was appointed Institute Director. The Advisory Board (Kuratorium) of Fraunhofer MEVIS convened on June 4, 2009, headed by Prof. Dr.-Ing. Erich. R. Reinhardt, at that time CEO of the Healthcare Sector of Siemens AG. Since early 2009, Fraunhofer MEVIS has been a member of the Fraunhofer Group for Information and Communication Technology (Fraunhofer-Verbund IuK).

In April 2010, the Fraunhofer MEVIS Project Group for Image Registration was established under the direction of mathematician Prof. Dr. Bernd Fischer at the University of Lübeck. In July 2013, Professor Fischer passed away following a short severe illness. The director of the MIC, Prof. Dr. Jan Modersitzki, was appointed new director of the Fraunhofer MEVIS Project Group for Image Registration in October 2014.

In October 2012, MEVIS founder Professor Peitgen retired after heading the institute for 17 years and his former deputy Prof. Dr. Horst K. Hahn succeeded as Interim Institute Director. Professor Hahn and Prof. Dr. med. Ron Kikinis were appointed new directors of Fraunhofer MEVIS in January and April 2014, respectively. Fraunhofer MEVIS was under dual leadership until February 2020.

During the transition phase of five years, the parent institute in Bremen (2009–2013) and the project group in Lübeck (2010–2014) have received funding from the States of Bremen and Schleswig-Holstein and have been co-financed by the European Regional Development Fund (ERDF). The mother institute in Bremen and the project group in Lübeck were positively evaluated by international review boards in May 2013 and 2014. They are under regular basic funding of the Fraunhofer-Gesellschaft since January 2014 and July 2015, respectively.

Between 2014 and 2018 the Fraunhofer MEVIS Advisory Board was chaired by Prof. Dr. Gábor Székely, Head of the Medical Image Analysis and Visualization Group at ETH Zurich. On June 20, 2018, Prof. Dr. Hans Maier, former President Diagnostic Imaging of Bayer Schering Pharma AG, was elected new chair of the Advisory Board with co-chair Walter Märzendorfer, former President Diagnostic Imaging of Siemens Healthineers.

The new Fraunhofer MEVIS institute building under construction in May 2019. The building located on the campus of the University of Bremen is funded in equal parts by the Federal Republic of Germany, the Federal State of Bremen, and the European Commission (ERDF). It is planned to be ready in spring 2021.


SCHREIBER
BauWatch

OPERATING AND ORGANIZATIONAL STRUCTURES

Fraunhofer MEVIS' interdisciplinary orientation is reflected in the institute's operating principles and organizational structure. Researchers are not bound to strict, hierarchically organized working groups, but act in a flexible network.

Three categories of strategic topics shape this network, with dedicated experts forming the nuclei of activities: organ- or disease-related clinical domains, technological core competences, and customer-oriented business areas.

Project teams are put together with team members from different technological and clinical credentials. This form of dynamic collaboration promotes cooperation and fosters cross-training, beneficial both to the individuals and to the institute as a whole.

Internal communication is governed by transparency and cooperation. Access to information is only restricted insofar as required by confidentiality agreements with customers or by legal constraints – otherwise sharing of information is encouraged and expected at all levels and is actively aided by exchange forums such as the social Wiki-based intranet (Confluence), morning meetings for all staff members and an active information policy by the leadership. Initiative by all staff members also beyond their current work assignment is highly encouraged.

To improve management, organization, and staff development, Fraunhofer MEVIS established a mentoring system in August 2014. Management responsibility was extended to a group of experienced staff members who act as mentors or co-mentors for mentees. Responsibilities of the mentors include the professional development of the mentee, the coordination between the goals of the institute and the mentee, as well as the identification and addressing of potential conflicts and problems.

Three male and three female persons of trust are elected from the staff to function as liaisons and mediators when needed.

As a result of the strategy process 2015/16, Fraunhofer MEVIS introduced a new structure of organizational entities (OEs) each with a responsible OE manager (OEV) as of April 2017.

The main objectives of the new OE structure are:

- clear allocation of responsibilities,
- delegation of project budgets, and
- strengthening of strategic focus.

The OEVs are by default mentor for the respective OE members. The mentees can freely choose their OE as well as the co-mentor. OEVs as well as additional colleagues bear specific strategic responsibility to the institute, especially for business areas and core competences. Alloced budgets must be explicitly used for appropriate strategic objectives. Objectives and budgets are coordinated by the OEVs in consultation with the institute directors and the financial management.

Overall responsibility for the institute is organized in a central leadership and administration structure. In 2019, the heads of the institute were

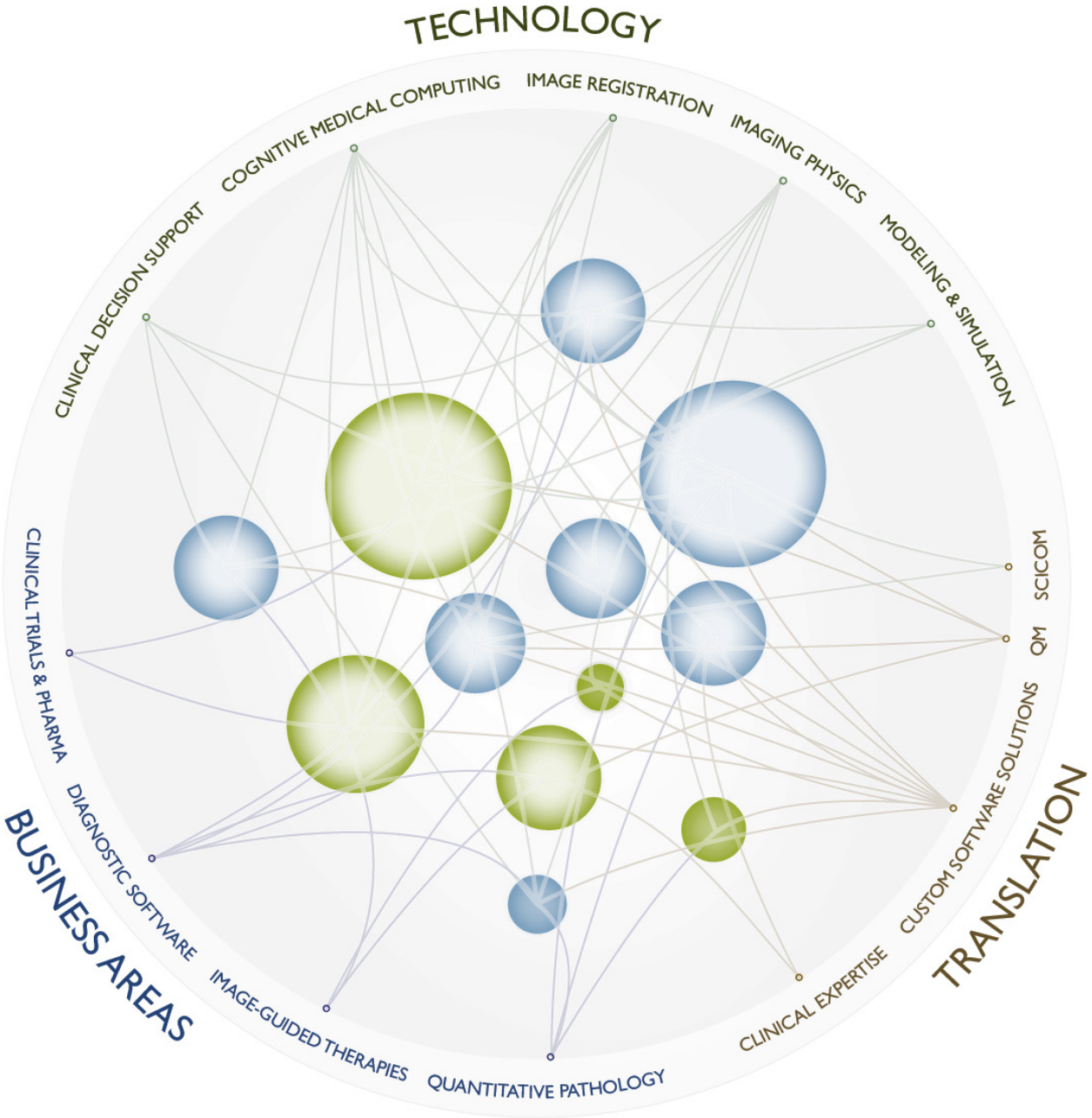
- Prof. Dr.-Ing. Horst K. Hahn (Institute Director),
- Prof. Dr. med. Ron Kikinis (Institute Director), and
- Dipl.-Betrw. Thomas Forstmann (Head of Administration)

Professor Kikinis left Fraunhofer MEVIS on March 1, 2020. Since then Professor Hahn is the sole director of the institute. His deputies are Prof. Dr. Tobias Preusser and Prof. Dr. Matthias Günther.

The heads are assisted in operational and strategic tasks by the OEVs and six leadership committees for human resources (LH), valorization (LV), research (LR), finance (LF), quality management (LQ), and IT security (LS).

The Advisory Board (Kuratorium, cf. next section) of Fraunhofer MEVIS is composed of persons with backgrounds in medicine, science, business, and research funding. It advises the management of Fraunhofer MEVIS in issues of scientific focus, strategic orientation, and clinical as well as industrial translation.

Illustration of the institute's operating principle and organizational structure. Project teams of various size, topic and funding are dynamically put together with team members from different technological and clinical credentials.


TECHNOLOGY
COGNITIVE MEDICAL COMPUTING
IMAGE REGISTRATION
IMAGING PHYSICS
MODELING & SIMULATION
CLINICAL DECISION SUPPORT
TRANSLATION
SCICOM
QM
CUSTOM SOFTWARE SOLUTIONS
CLINICAL EXPERTISE
QUANTITATIVE PATHOLOGY
IMAGE-GUIDED THERAPIES
DIAGNOSTIC SOFTWARE
CLINICAL TRIALS & PHARMA
BUSINESS AREAS

ADVISORY BOARD

The eleventh meeting of the Advisory Board took place in Bremen on Wednesday, June 19, 2019. Dr. Birgit Geier from the Fraunhofer headquarters in Munich gave the presentation on the current situation of the Fraunhofer-Gesellschaft. In his presentation on Fraunhofer MEVIS, Professor Horst Hahn, head of the institute, reported on recent developments in the focus and structure of the institute and outlined medium-term prospects and strategic plans.

Professors Matthias Günther and Fabian Kiessling from MEVIS sites Bremen and Aachen gave the Advisory Board in-depth insights into the cross-manufacturer MR sequence development as well as the challenges for integrated clinical diagnostics. The members of the Advisory Board welcomed the development of Fraunhofer MEVIS, made valuable recommendations for future priorities and expressed their appreciation and thanks to the staff of the institute.

For PD Dr. med. Christian Meisel ended the membership in the Advisory Board in 2019. The president of the Fraunhofer-Gesellschaft and the directors of Fraunhofer MEVIS thanked him for his great effort and dedication. Four new members were appointed to the Fraunhofer MEVIS Advisory Board:

- Prof. Dr. Ruth Knüchel-Clarke, Director of the Institute for Pathology at the University Hospital of RWTH Aachen
- Dr. Bernd Roß, Ministry of Education, Science and Culture of the State of Schleswig-Holstein, Kiel
- Stefan Widensohler, Managing Partner of KRAUTH Invest GmbH & Co. KG, Hamburg
- Dr. Christoph Zindel, President Diagnostic Imaging at Siemens Healthcare GmbH, Forchheim

Chair

Prof. Dr. Hans Maier (since 2009)
formerly Bayer Schering Pharma AG, Berlin

Co-Chair

Walter Märzendorfer (since 2009)
formerly Siemens Healthineers, Forchheim

Industry

PD Dr. med. Christian Meisel (2016–2019)
Roche Diagnostics GmbH, Penzberg

Stefan Widensohler (since 2019)
Krauth Invest GmbH & Co. KG, Hamburg

Dr. Christoph Zindel (since 2019)
Siemens Healthcare GmbH, Forchheim

Medicine

Prof. Dr. med. Ruth Knüchel-Clarke (since 2019)
Institute for Pathology
RWTH Aachen

Astrid Lurati (since 2018)
Executive Board
Charité – Universitätsmedizin, Berlin

Prof. Dr. med. Mathias Prokop (since 2014)
Radboud University Medical Centre
Nijmegen, The Netherlands

Science

Prof. Dr. Craig Garner (since 2017)
German Center for Neurodegenerative Diseases (DZNE)
Charité – Universitätsmedizin, Berlin

Prof. Dr. Dr. h.c. Jürgen Hennig (since 2009)
Department of Radiology, Medical Physics
University Medical Center Freiburg

Prof. Dr. Gábor Székely (since 2009)
Image Science Division
ETH Zurich

University of Bremen

Prof. Dr. Jens Falta (since 2010)
Dean of Faculty Physics / Electrical Engineering
University of Bremen

Prof. Dr. Kerstin Schill (since 2014)
Faculty Mathematics / Computer Science, University of Bremen
Rector of Hanse-Wissenschaftskolleg, Delmenhorst

Jacobs University Bremen

Dr. Alexander Ziegler-Jöns (since 2010)
Science & Technology Transfer
Jacobs University Bremen

Research Funding

Dr. Ursula Niebling (since 2009)
Bremen Senator of Science, Health and Consumer Protection
Department of Scientific Planning and Research Promotion, Bremen

Dr. Bernd Roß (since 2019)
Ministry of Education, Science and Culture
State of Schleswig-Holstein, Kiel

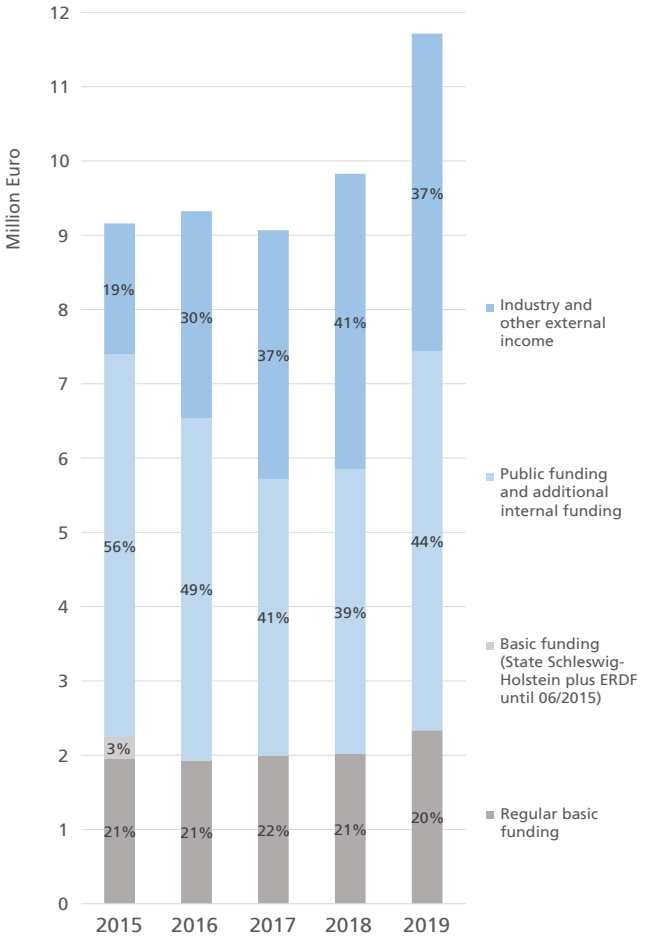
Attendees of the eleventh assembly of the Fraunhofer MEVIS Advisory Board in Bremen on June 19, 2019.

THE INSTITUTE IN FIGURES

Budget and Earning Trends

The overall earnings in 2019 rose by 1 886 T€ to 11 713 T€. The industrial earnings increased significantly by +7% compared to the previous fiscal year (PFY). This is mainly due to our strategic work base with Siemens and Varian. Our basic funding rose significantly too by +16% to 2 335 T€ (PFY: 2 015 T€). Earnings from public and internal sources increased by +33% compared to the previous year.

The overall budget rose by +19%. This is mainly due to the increase in salaries (+1 549 T€), due to the growth in the workforce, i.e. the operating budget (OB) increased by +16% to 11 126 T€. The investment budget (IB) increased by +134% to 587 T€.



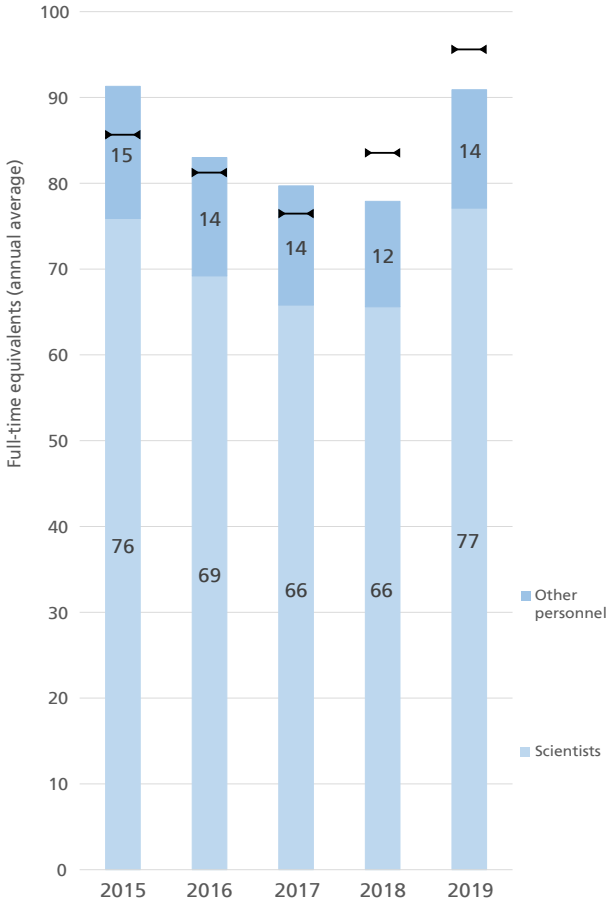
Earnings in million euros in the period from 2015 to 2019.

Operating Budget (OB), Investment Budget (IB) and Total Budget in T€:

	2015	2016	2017	2018	2019
OB:	8 951	8 917	8 567	9 577	11 126
IB:	207	407	500	251	587
Total:	**9 158**	**9 324**	**9 067**	**9 828**	**11 713**

Human Resources

The overall average number of persons employed by Fraunhofer MEVIS rose significantly in 2019. This is due to a good project situation and a corresponding effort to acquire new staff. The number of scientists and the overall number of employees under contract increased by 13 full-time equivalents (FTE) in 2019. We expect further personnel growth in 2020.



Development of employment figures for scientists and other personnel shown as annual average FTE between 2015 and 2019. The horizontal bars indicate the staff FTE at the end of the year.

Full-time equivalents as annual average (avg FTE) and at the end of the year (eoy FTE):

	2015	2016	2017	2018	2019
avg FTE:	91.3	83.0	79.7	77.9	90.9
eoy FTE:	85.9	81.3	77.4	83.7	96.1

THE FRAUNHOFER-GESELLSCHAFT

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

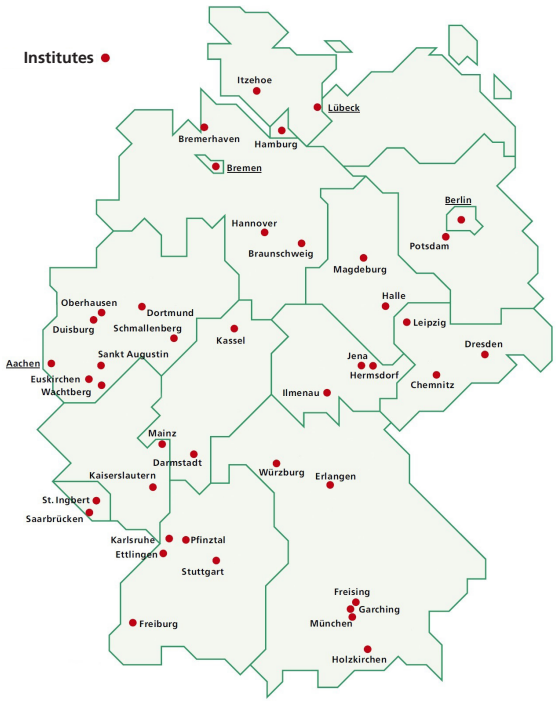
At the Fraunhofer-Gesellschaft, interdisciplinary research teams work together with partners from industry and government in order to transform novel ideas into innovative technologies, to coordinate and realize key research projects with a systematic relevance, and to strengthen the German and the European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

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

Applied research also has a knock-on effect that is felt way beyond the direct benefits experienced by the customer: our institutes boost industry's performance and efficiency, promote the acceptance of new technologies within society, and help train the future generation of scientists and engineers the economy so urgently requires.

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

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



Locations of Fraunhofer Institutes in Germany. In 2019, Fraunhofer MEVIS had major sites in Bremen (headquaters), Lübeck, Berlin and Aachen plus additional offices in Hamburg, Heidelberg, Nijmegen and Boston.

THE YEAR 2019

CHRONICLE

January 1, 2019
Fraunhofer MEVIS celebrates its 10th anniversary of joining the Fraunhofer-Gesellschaft and changes the institute's name to »Fraunhofer Institute for Digital Medicine MEVIS«.

January 18-19, 2019
Fraunhofer MEVIS offers a hands-on workshop on radiomics and machine learning for young radiology scientists within the program »Forscher für die Zukunft« (FFZ) of the Deutsche Röntgengesellschaft e.V.

January 21-23, 2019
Fraunhofer MEVIS' quality management system according to EN ISO 13485 passes the surveillance audit by DEKRA in Bremen and Lübeck.

January 26, 2019
Fraunhofer MEVIS participates at the 5th Raw Science Film Festival« in Los Angeles, California and wins »Industry Award for Best Infographic«.

February 15, 2019
The board of directors of the Fraunhofer ICT Group meets at Fraunhofer MEVIS in Bremen.

February 16-21, 2019
Fraunhofer MEVIS attends the SPIE Medical Imaging Conference in San Diego, California with five oral presentations, three live demonstrations, two courses on Deep Learning, and two conference/workshop chairs.

February 28, 2019
Fraunhofer MEVIS hosts the third meeting of the artificial intelligence cluster BREMEN.AI in cooperation with the labs of the Institute for Artificial Intelligence at the University of Bremen.

March 28, 2019
Girls' Day activities offered by Fraunhofer MEVIS in Bremen and Lübeck.

April 4, 2019
Fraunhofer MEVIS is partner in Bremen's first Leibniz ScienceCampus on »Digital Public Health« which further strengthens the cooperation with the Leibniz Institute for Prevention Research and Epidemiology (BIPS) and the University of Bremen.

May 24, 2019
»Science Meets Fiction« workshop on storytelling for Fraunhofer MEVIS scientists organized in cooperation with the ifs internationale filmschule köln and the Foundation for STEM-Entertainment-Education-Excellence (MINTEEE).

June 15, 2019
Fraunhofer MEVIS presents itself at the booth of the U Bremen Research Alliance at the University of Bremen OPEN CAMPUS.

June 19, 2019
Roofing ceremony for Fraunhofer MEVIS' new institute building on the campus of the University of Bremen.

June 19, 2019
Eleventh meeting of the Fraunhofer MEVIS Advisory Board (Kuratorium) in Bremen.

July 11, 2019
Fraunhofer MEVIS Director Horst Hahn invited by Minister Anja Karliczek to the Federal Ministry of Education and Research (BMBF) in Berlin for an expert discussion on »AI in Medicine«.

August 29, 2019
Fraunhofer MEVIS hosts the »32. Treffpunkt: Medizintechnik der Zukunft« on »New Technologies in Imaging« at the Fraunhofer-Forum Berlin in cooperation with the »Cluster Gesundheitswirtschaft Berlin-Brandenburg« (HealthCapital) and the Berlin Chamber of Industry and Commerce (IHK).

October 1 – November 14, 2019
The artists Jake Tan and Ernest Wu from Nanyang Technological University Singapore are visiting Fraunhofer MEVIS within the

artist-in-residency project »STEAM Imaging II« jointly hosted by Fraunhofer MEVIS, Ars Electronica Center in Linz, and the International Fraunhofer Talent School Bremen.

October 3, 2019
Fraunhofer MEVIS joins the initiative »Maus Türöffner-Tag« by WDR's »Die Sendung mit der Maus« and opens the doors of its MRI center.

October 4, 2019
Fraunhofer MEVIS, ifs internationale filmschule köln, and the Foundation for STEM-Entertainment-Education-Excellence (MINTEEE) organize a two-day event in Cologne, dedicated to the topic »Artificial Intelligence in Fiction and Reality«.

October 13-17, 2019
Fraunhofer MEVIS presents itself at the International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI 2019) in Shenzhen, China with one oral and two poster presentations as well as two challenges.

November 14, 2019
Fraunhofer MEVIS presents the short film »Digital Medicine, Arts and STEAM: Before Us Lies ETERNERDY« in the exhibition »Schaufenster Wissenschaft – Highlights der Bremer Forschung« in the »Haus der Wissenschaft Bremen« until January 27, 2020.

November 19-21, 2019
Fraunhofer MEVIS' quality management system according to EN ISO 13485 successfully passes the recertification audit by DEKRA in Bremen and Lübeck.

November 25-26, 2019
Fraunhofer MEVIS presents itself at the booth of the U Bremen Research Alliance at the science journalism conference »Wissenswerte 2019« in Bremen.

December 1-6, 2019
Fraunhofer MEVIS presents its latest developments in AI-related software solutions at the »105th Scientific Assembly and Annual Meeting of the Radiological Society of North America« (RSNA) in Chicago, USA.

HIGHLIGHTS 2019

New Institute Name after Ten Years at Fraunhofer-Gesellschaft

On January 1, 2019, exactly ten years after joining the Fraunhofer-Gesellschaft, the former »Fraunhofer Institute for Medical Image Computing MEVIS« changed its official name to »Fraunhofer Institute for Digital Medicine MEVIS«. The short form »Fraunhofer MEVIS« and the Institute's logo continued to be valid. The new institute name underscores the mission of Fraunhofer MEVIS to drive the transformation of tomorrow's digital, integrated precision medicine through systematic computer support.

Fraunhofer MEVIS at SPIE Medical Imaging 2019

Artificial intelligence (AI) and adaptive algorithms are gaining increasing importance in medicine. This trend was also reflected by the program of the SPIE Medical Imaging conference which took place in San Diego, California, from February 16 to 21. Fraunhofer MEVIS was again represented with several contributions at this renown convention including a co-chair of the Computer-Aided Diagnosis conference, a two-day training course on Deep Learning, a live demonstrations workshop, and five oral presentations.

Leibniz ScienceCampus »Digital Public Health«

Fraunhofer MEVIS is partner in Bremen's first Leibniz ScienceCampus on digital public health. The research network established in May 2019 will further strengthen the cooperation between the Leibniz Institute for Prevention Research and Epidemiology (BIPS), the University of Bremen, and Fraunhofer MEVIS, which is already part of the scientific priority area of health sciences in Bremen. Among other things, the new Leibniz ScienceCampus »Digital Public Health« will address the question of how digital technologies can be integrated effectively, fairly, and in accordance with the principles of human dignity into prevention, health promotion, and other public health tasks.

Deep Learning: Ideations for Fictional Narratives in Digital Medicine

To fathom the co-creation of STEM scientists and (future) filmmakers is the aim of Fraunhofer MEVIS' collaboration with the Stiftung für MINT-Entertainment-Education-Excellence (MINTEEE) and the ifs internationale filmschule köln. In 2019, the focus was on a three-part exploration of sustainable formats of cooperation, promoting a mutual understanding, teaching and learning in hands-on workshops about narrative design, digital medicine and ideation for fiction. In May 2019, the first part, the hands-on workshop for STEM scientists »Narrative Design – Storytelling for the communication of scientific content – How opportunities, risks and ethical issues of research and innovation can be conveyed through cinematic stories« took place at Fraunhofer MEVIS, held by Prof. Dr. Joachim Friedmann (ifs) and Dr. Marion Esch (MINTEEE). The second and third parts, including hands-on workshops for film students and filmmakers to learn about digital medicine and train an AI, held by Fraunhofer MEVIS scientists as well as the confluence of the exploration in an collaborative ideation session, took place in October 2019 at ifs in Cologne.

Roofing Ceremony for the new Fraunhofer MEVIS Institute Building

Six months after laying the foundation stone, Fraunhofer MEVIS celebrated the roofing ceremony for its new institute building on the campus of the University of Bremen on June 19, 2019. Designed as a workshop for digital medicine, the new MEVIS building will create a place where software tools can be developed and tested, where people from different disciplines can meet and help shape the future of medicine. Around 100 people took part in the roofing ceremony. In addition to the partners involved in the construction project, several members of the advisory board and employees of Fraunhofer MEVIS followed with great interest the setting of the topping-out crown on the roof of the building.

Horst Hahn invited to AI Expert Discussion at the BMBF

Fraunhofer MEVIS Director Horst Hahn visited Federal Research Minister Anja Karliczek at the Federal Ministry of Education and Research (BMBF) for an expert discussion on »AI in Medicine« on July 10, 2019. Professor Hahn kicked off the discussion series »Karliczek. Impulses. How we want to use artificial intelligence.« at the Federal Ministry of Education and Research (BMBF) in Berlin with a keynote lecture on »Pathfinder to human-computer medicine – what AI can do for healthcare«. Together with the Minister of the BMBF, Anja Karliczek MdB, experts from science and practice discussed the topic »Artificial intelligence as assistant doctor: Can AI save human lives?«

Fraunhofer MEVIS Co-Hosts »Treffpunkt: Medizintechnik der Zukunft«

Together with the »Cluster Gesundheitswirtschaft Berlin-Brandenburg« (HealthCapital) and in cooperation with the Berlin Chamber of Industry and Commerce (IHK), Fraunhofer MEVIS hosted the »32. Treffpunkt: Medizintechnik der Zukunft« on new imaging technologies at the Fraunhofer Forum Berlin on August 29. About 160 participants from medicine, science, industry and research funding attended the full-day event, which is recognized with 4 points for continuing medical education by the »Ärztekammer Berlin«. In five sessions, each of which was concluded by a panel discussion, experts gave an overview of the state-of-the-art in the fields of contrast agents, imaging innovations, image analysis, artificial intelligence and research funding. Fraunhofer MEVIS contributed three of the 19 presentations itself.

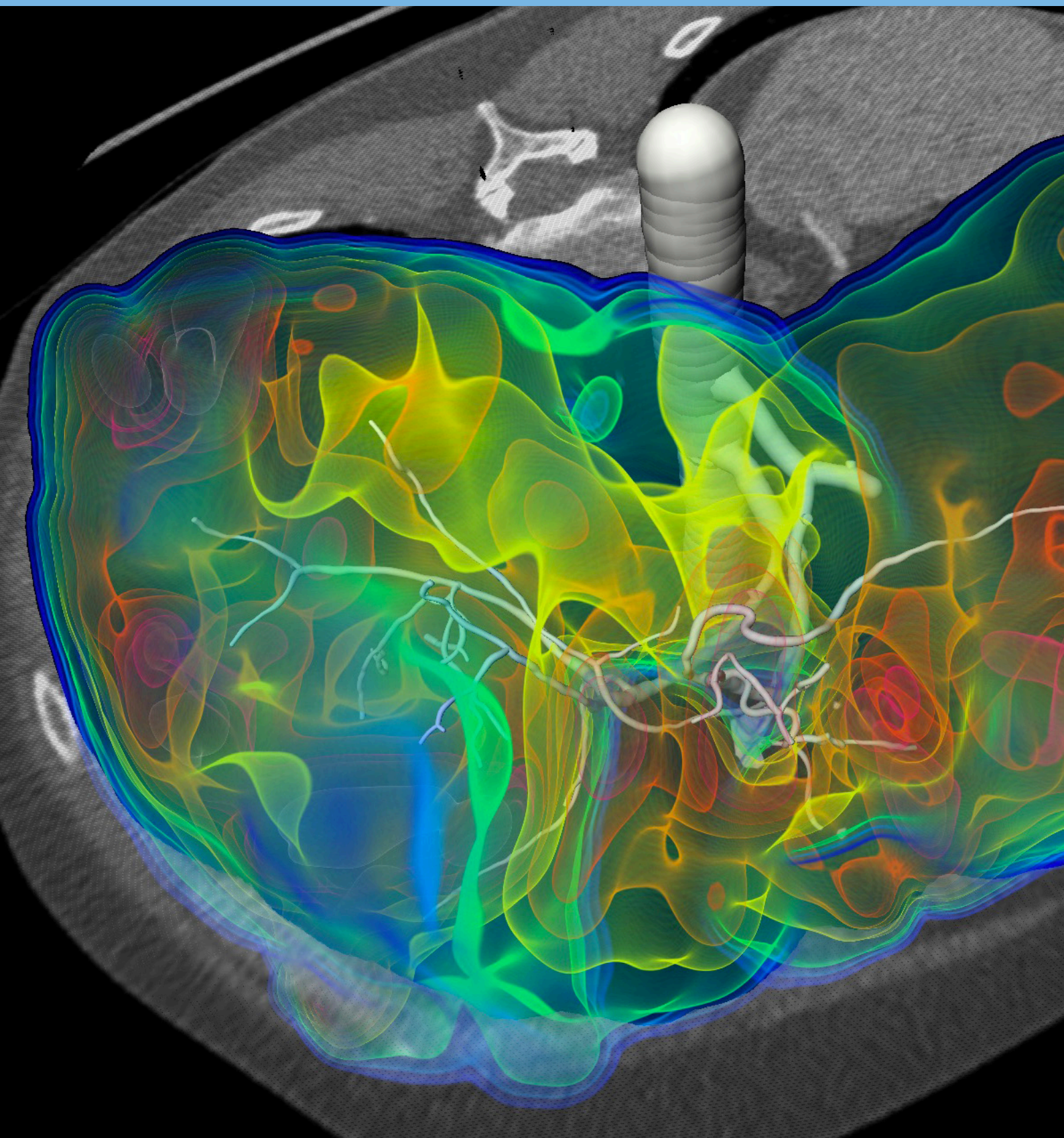
Open House With The Mouse at Fraunhofer MEVIS

Fraunhofer MEVIS opened the doors and invited kids and their parents to visit the MRI Center at Fraunhofer MEVIS on October 3, 2019. MEVIS joined the initiative »Maus Türöffner-Tag« by the WDR »Die Sendung mit der Maus« opening doors all over Germany to discover exciting and interesting facts and sites. Fraunhofer MEVIS researchers showed curious kids and parents how medical imaging with MR works. In practical experiments, they demonstrated how to get images from the inside of melons and lemons without slicing, and explained how MR images of the brain and the beating heart are acquired.

Meet Us at RSNA 2019 and Experience Our AI-based Solutions

Fraunhofer MEVIS presented its latest developments in AI-related software solutions at the 105th Scientific Assembly and Annual Meeting of the Radiological Society of North America (RSNA) which took place in Chicago, Illinois from December 1 to 6. Visitors were invited to the Fraunhofer MEVIS booth to experience customizable solutions for data preparation and AI training as well as a number of medical applications according to the motto »AI+You: Fusing Natural and Artificial Intelligence«. Among those are cardiovascular, hepatic, neurological, and interventional applications as well as convenient annotation tools and AI infrastructure to support the training of deep learning networks. In addition Fraunhofer, MEVIS presented the free interactive annotation software »MEVIS draw« for creating and editing segmentations on 3D medical images such as CT or MR imagery.

Cut out of the image »Individual Dose of Color« which took 4th place at the »RSNA 2017 Image Contest« in the category »Radiology Art: Medical images altered into works of art«. The 3D visualization illustrates the individual dose distribution for a liver radioembolization.



AWARDS 2019

Industry Award at Raw Science Film Festival 2019
The second year in a row, the work of Fraunhofer MEVIS was recognized by the scientific documentary industry at the Raw Science Film Festival 2019 in Los Angeles, USA on January 26. The short movie »Digital Medicine, Arts, and STEAM: BEFORE US LIES ETERNERDY« realized by the Fraunhofer MEVIS scicom team Bianka Hofmann, Alexander Köhn, and Mathias Neugebauer in collaboration with artists Ina Conradi and Mark Chavez from NTU Singapore won the »Industry Award for Best Infographic«.

1st Place at ISBI 2019 Challenge
The Fraunhofer MEVIS team represented by Johannes Lotz, Nick Weiss and Stefan Heldmann was ranked as the final #1 in the »Automatic Non-rigid Histological Image Registration (ANHIR)« challenge at the IEEE International Symposium on Biomedical Imaging (ISBI) held in Venice, Italy from April 8 to 11.

Fellow of the ISMRM Society
The International Society for Magnetic Resonance in Medicine (ISMRM) appointed Ron Kikinis as »Fellow of the Society« for his significant contributions to the Society in fulfilling its scientific and educational mission at the ISMRM's annual meeting held in Rotterdam, The Netherlands from May 11 to 16.

Harvard Medical School Mentoring Award 2019
Ron Kikinis – Professor of Radiology at Harvard Medical School, Professor of Medical Image Computing at University Bremen, and Director of Fraunhofer MEVIS – has been awarded with the 2019 »A. Clifford Barger Excellence in Mentoring Award« at Harvard Medical School in Boston, USA on May 21.

EG VCBM Full Paper Honorable Mention Award 2019
Fraunhofer MEVIS scientist Lars Walczak receives Full Paper Honorable Mention Award for his paper »Using Position-Based Dynamics for Simulating the Mitral Valve in a Decision Support System« at the annual Eurographics Workshop on Visual Computing for Biology and Medicine (EG VCBM) held in Brno, Czech Republic from September 4 to 6.

Gorter Price 2019
Fraunhofer MEVIS scientist Klaus Eickel wins third place of the Gorter Price at the annual meeting of the German Chapter of the International Society for Magnetic Resonance in Medicine (ISMRM) held in Kiel, Germany on September 12 and 13.

ESMRMB Early Career Fellowship 2019
Fraunhofer MEVIS scientist Daniel Hoinkiss awarded the Early Career Fellowship by the European Society for Magnetic Resonance in Medicine and Biology (ESMRMB) held in Rotterdam, The Netherlands from October 3 to 5.

1st and 3rd Place at MICCAI 2019 Challenges
Fraunhofer MEVIS scientist Luca Canalini ranked as #1 in the challenge »Correction of Brain shift with Intra-Operative Ultrasound (CuRIOUS 2019)« with his contribution »Registration of ultrasound volumes based on Euclidean distance transform«. Constantin Disch ranked as #3 in the sub challenge »Surgical Workflow and Skill Analysis« as part of the Endoscopic Vision Challenge. Both challenges took place as satellite events at the International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI 2019) held in Shenzhen, China from October 13 to 17.

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IMPRESSUM

Text
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