

Annual Report 2023/2024

Mathematics as a Key to Health

Cover

The hyperbola in front of the Fraunhofer Center is a significant landmark of our institute. The official title of the artist Martin Willing from Cologne is „Hyperboloid“.

The artwork can also be interpreted as a DNA helix and thus symbolizes a key that provides essential access to health.

Annual Report 2023/2024

Mathematics as a Key to Health

Mathematics as a Key to Health

Dear readers,

“Health” is the main topic of our annual report this year. Health is said to be the greatest good. Hardly a day goes by without us thinking or talking about our own health or the physical and mental health of people close to our hearts – or reflexively wishing someone “Good health!”.

Mathematics as a Key to Health

Mathematics can improve health: our research has been helping to improve medical care for many years. We have used mathematics to initiate major advances in radiotherapy, played a key role in planning vaccine production against COVID-19, optimized the production of personalized pharmaceuticals and recently contributed to the development of an app for assessing one’s own mental resilience and an energy-efficient chip for detecting atrial fibrillation.

At our institute we are working on exciting health-related research projects, particularly many of them in our division “Optimization”, which is why we have created a separate department there. Optimization in the Life Sciences” focuses on projects in medicine, healthcare and social sector and medical technology. Our mathematics supports decision-making and helps to optimize processes. You can find out more about this new department in the cover story of this annual report.

Carrying out Socially Relevant Research Work

Working as a mathematician is versatile! This is demonstrated by the numerous projects we present in our annual report: We look at energy, digitalization, process engineering, mobility and quantum computing – all important topics of our time and relevant to society. This aspect is very important to many of our employees and they choose to work for us for precisely this reason. This is one of the insights we gained from our employee survey in 2023.

Leading the Way in Transfer to Industrial Application

A lot has happened since we were founded in 1996. We have grown from just about 60 employees back then to over 550 employees today. We look back with pride on what has been achieved here in Kaiserslautern. We have succeeded in developing our scientific discipline – mathematics – into an “enabling technology” for almost all economically relevant fields of technology. Our annual report reflects this to some extent. And this is also confirmed by the auditors who accompanied us through our strategy process last year. In their report, they write: “The Fraunhofer ITWM is a pioneer and role model for numerous initiatives in Germany and Europe. In the unanimous opinion of all auditors, it is the world’s leading institute for the transfer



**We research important
topics of our time.«**

Prof. Dr. Anita Schöbel,
Director of the Fraunhofer ITWM



of mathematical research into industrial applications.” We are all proud of this and I am delighted to give you an insight into our research and project work in the 2023/24 annual report.

I hope you enjoy reading it and invite you to get in touch with the contacts listed for further information!

Kind regards

Anita Schöbel

Prof. Dr. Anita Schöbel
Director of the Fraunhofer ITWM

A comprehensive overview of our other research activities on medicine and health can be found online.



www.itwm.fraunhofer.de/healthcare



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The Institute in Profile

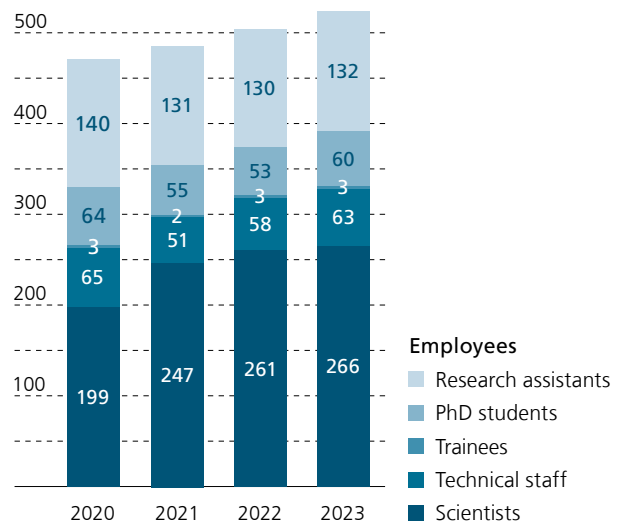
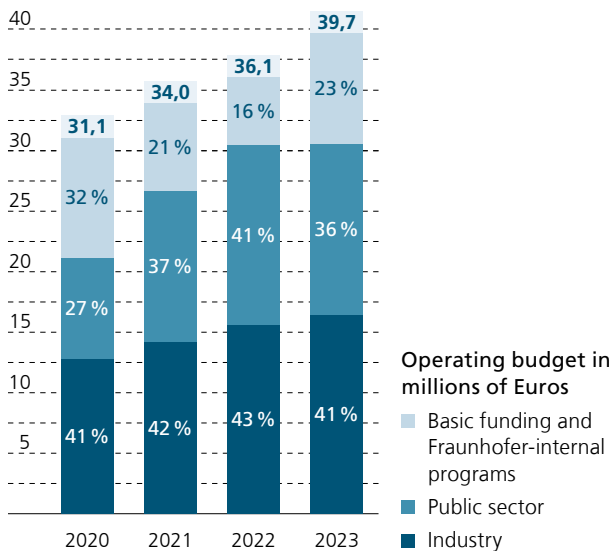
Computer simulations are indispensable when designing and optimizing products and processes. Mathematics plays a fundamental role in the development of this digital world. After all, it is the technology with which these images are generated and efficiently converted into software, the raw material of the models and the core of every computer simulation. We have succeeded in developing our scientific discipline mathematics into an “enabling technology” for almost all economically relevant fields of technology.

At the Fraunhofer ITWM we do not only want to build the bridge between the real and virtual world ourselves, but also to be the link between university mathematics and its practical implementation. Therefore, the close connection to the Department of Mathematics at the University of Kaiserslautern-Landau (RPTU) plays a special role.

Industries – Who Do We Work For?

The expertise of our departments and the broad spectrum of their fields of application are used in numerous industries. The following applies to all of them: our modeling and simulation expertise generates real competitive advantages on the market.

- Process engineering, mechanical and plant engineering
- Automotive industry and suppliers
- Medicine and medical technology
- Energy and raw materials industry
- Technical textiles
- Information technology
- Finance industry





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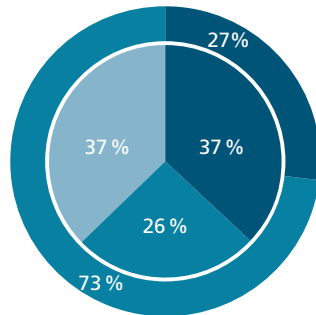
(as at 2023)

The Institute in Figures



Industrial Yields

- Regional companies (closer than 150 km)
- Other German companies
- International companies
- Small and medium-sized enterprises
- Other



Research

16.4 million in industrial revenue, 175 industrial clients, 339 industrial projects



Qualifying and Publishing

21 dissertations, 26 master's theses, and 169 publications

Complete list under:
<https://s.fhg.de/publica2023-itwm>



Teaching

At 9 universities and colleges, 16 employees – including 4 professors – worked a total of 137 semester hours per week.



Networking

2 Fraunhofer Groups
and 12 alliances and research areas



International

The Fraunhofer ITWM employs people from all over the world:
39 from Europe (except Germany), 66 from Asia, 7 from Africa, 9 from America, 1 from Australia



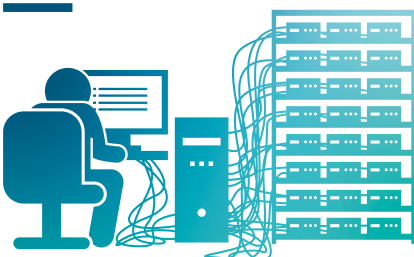
Presenting

We participated in 214 trade fairs and events as exhibitors, with presentations and posters or as providers of workshops



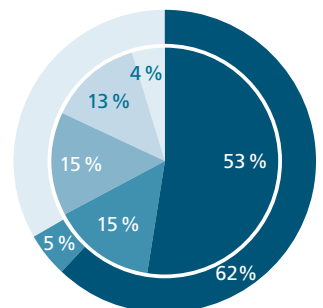
Fields and Doctoral Degrees

Computing



More than 7,500 computer cores provide the necessary computing power.

- Mathematics
 - Computer science
 - Physics
 - Engineering
 - Other
- Doctorate
 - Habilitated



Cooperations and Spin-Offs

Networking within the Fraunhofer-Gesellschaft

A large network and bright minds are crucial for the success of projects. Our specific mathematical expertise makes us a sought-after and valued cooperation partner within the Fraunhofer-Gesellschaft. We are a member of the Information and Communication Technology Group IUK, have guest status with the MATERIALS Group and are represented in various leading market-oriented alliances:

- Plant, machinery and vehicle construction
- Chemical industry
- Digital economy
- Energy industry
- Healthcare industry
- Mobility industry
- Food industry



Fraunhofer-Chalmers Research Center for Industrial Mathematics

One of our most important international partners is the Fraunhofer-Chalmers Research Center for Industrial Mathematics, or FCC for short, which was founded in 2001 by Fraunhofer and Chalmers University in Gothenburg. In 2023, 56 employees were working there on topics such as fast algorithms, multiphysics and real-time simulation, robot path planning, bioinformatics and statistics as well as data mining. Areas of application include virtual product and process development. The budget amounted to around 6.3 million euros.



www.fcc.chalmers.se

Center of Excellence Simulation and Software-Based Innovation

Transferring new results and ideas into practice as quickly as possible is the mission of the Center of Excellence Simulation and Software-Based Innovation in Kaiserslautern. The Center transforms scientific results into innovations and thus meet the requirements of industry and society. In the Fraunhofer internal ranking of 21 High-Performance Centers, it took first place in 2023!



www.leistungszentrum-simulation-software.de/en

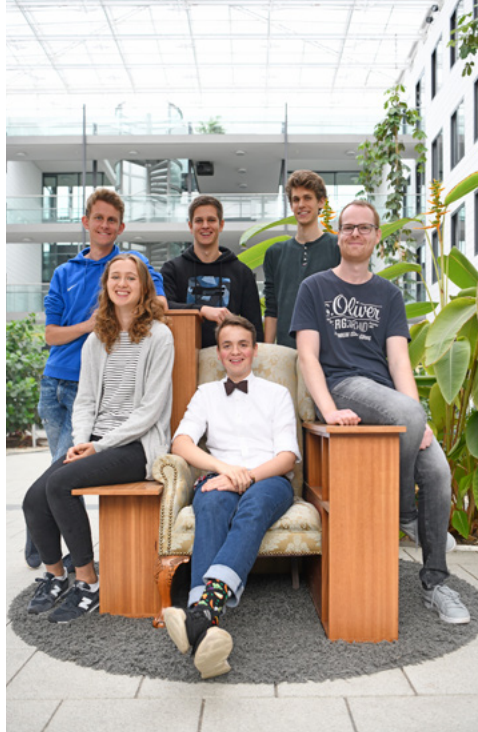
Felix Klein Center for Mathematics

The Felix Klein Center for Mathematics (FKZM) is an institutional link between the Department of Mathematics at RPTU Kaiserslautern-Landau and the Fraunhofer ITWM.

The focus is on promoting young talent. This takes the form of modeling weeks for schools or scholarships and a mentoring program for mathematics students.



www.felix-klein-zentrum.de



Many young people benefit from our scholarship.

Spin-Offs

The successful transfer of research at our institute is also reflected in the seven spin-offs that we have launched since 2009. They continue to be important partners of our institute for new developments.

- **flexStructures** – Specific engineering projects and services for the simulation of flexible components
- **Math2Market** – Comprehensive software service, such as GeoDict®, an innovative simulation software for digital materials research and development
- **Produktinformationsstelle Altersvorsorge PIA** – Risk/reward classification of subsidized pension products
- **Sharp Reflections** – Big data computing technologies for the future of seismics
- **ThinkParQ** – Fast and scalable solutions for all performance-oriented environments such as HPC, AI and deep learning
- **Wendeware AG** – Software ecosystem for the energy transition
- **UNEEC Systems** – Distribution of the highly efficient STX processor technology (stencil and tensor accelerator)



www.itwm.fraunhofer.de/networks



Highlights 2023/2024 – Awards

A year at Fraunhofer ITWM is filled with numerous events related to our research work. Our employees took part in over 200 events in 2023. It is difficult to choose which of these is a “highlight”, because the researchers put their heart and soul into each of our projects. We have picked out a few special moments from the past year to give you an impression of how work, research and sometimes even celebrations take place at our institute.

Science Award for Anita Schöbel

At the annual conference of the Society for Operations Research (GOR), Prof. Dr. Anita Schöbel received the GOR Science Prize, endowed with 8,000 euros, for her entire body of work. Every two years, the society awards this prize to researchers for exceptional achievements in the development of the focus area “Operations Research”. In her acceptance speech, Schöbel emphasized how relevant OR has been for her research and her career to date. “It is wonderful to advance the field in dedicated teams on so many levels. The award confirms to me that this is perceived in the same way in the community. Even though the award actually honors a lifetime achievement, my work here is of course far from over!”



www.itwm.fraunhofer.de/gorprize_anita_schoebel

Special Award
for Our Institute
Director





ICT Dissertation Award for Sebastian Blauth

Dr. Sebastian Blauth from our “Transport Processes” department has been awarded first place in the ICT Dissertation Award of the Fraunhofer ICT Group for his outstanding dissertation. The prize is endowed with 5,000 euros. The Group awards the prize annually for research work that deals with innovative developments and technologies in the fields of computer science, mathematics or natural sciences. Read more about Blauth’s research on page 61.



s.fhg.de/ICT-Dissertation-S-Blauth-en



Award of the Sparkassenstiftung for Tania Jacob

The Foundation honored Tania Jacob (department “Financial Mathematics”) for her outstanding achievement with an award for her Master’s thesis on the detection of anomalies in component manufacturing processes. It is not only her research work that is impressive, but also Jacob’s career: after several years as a software developer in Australia, the 41-year-old decided to change career direction and embark on a new Master’s degree program. In 2020, she came to the Fraunhofer ITWM and while studying at RPTU.



www.itwm.fraunhofer.de/interview_tania_jacob_en

Highlights 2023/2024 – Events

International and Interdisciplinary: ISOLDE 2023

Together with the “Optimization” working group of the University of Kaiserslautern-Landau (RPTU), the Fraunhofer ITWM hosted the ISOLDE (“International Symposium on Locational Decisions”) conference in 2023. Prof. Dr. Anita Schöbel was the main organizer of the conference. Around 80 scientists from the operations research community from 18 countries came together for five days in Kaiserslautern and at the second conference venue in Baden-Baden. The participants from the disciplines of mathematics, economics, engineering and geography experienced compact days with a balanced mix of conference and networking opportunities.



www.itwm.fraunhofer.de/pm-isolde-en



Honor to Whom Honor Is Due

The department “Financial Mathematics” and the RPTU Kaiserslautern celebrated Prof. Dr. Ralf Korn’s 60th birthday with a special workshop. Many mathematicians whose professional careers are closely linked to him came to our institute for the event. Korn founded the “Financial Mathematics” department and continues to be involved in research as a consultant to the Fraunhofer ITWM. Impressive figures are a must when honoring a mathematician: Korn has supervised 84 diploma theses, 109 master’s theses, 22 bachelor’s theses and 60 doctorates up to the time of the event and has taken around 1200 oral examinations at RPTU.



www.itwm.fraunhofer.de/workshop-korn-en



KLAIM 2023

Kaiserslautern Applied and Industrial Mathematics Days



KLAIM 2023: Mathematics in Application

The “Kaiserslautern Applied and Industrial Mathematics Days” (KLAIM), initiated by Fraunhofer ITWM and RPTU, took place for the second time in September 2023. They offer a platform for mathematicians from academia, research laboratories and industry to exchange ideas and present current results. Around 60 presentations were submitted and offered a varied program. The second edition of KLAIM focused on the synthesis of models and data.

More than
100
people took
part in KLAIM.



www.itwm.fraunhofer.de/klaim2023-en

Promoting Talents

More than 300 students were guests at the Fraunhofer ITWM in 2023. Whether at events for advanced courses or school classes, two Math Talent Schools and a ceremony for the participants of the Mathematical Olympiad – the Fraunhofer ITWM is happy to host young math enthusiasts and offers them insights into a varied professional environment.



Highlights 2023/2024 – Projects

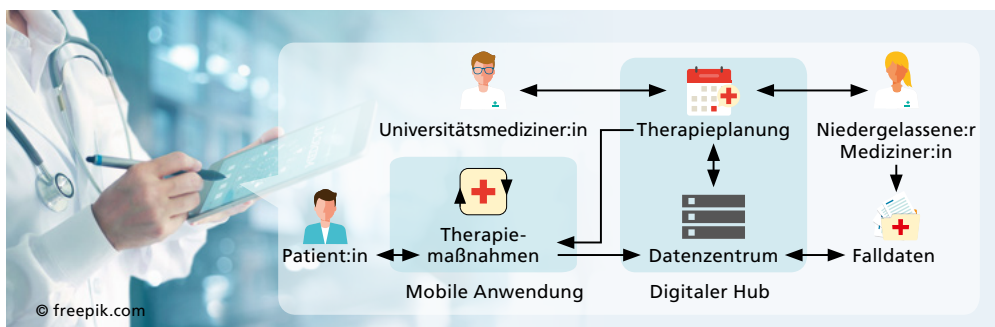


State Government Funds Preliminary Research

Biotechnology and quantum computing are two important research priorities for the state of Rhineland-Palatinate, which is why Science Minister Clemens Hoch brought two funding decisions to Kaiserslautern in March 2023. The Rhineland-Palatinate Quantum Initiative (QUIP) and the MaTBiZ project (microstructure design and additive manufacturing of a chromatography column for separating biological cells), which is based at the Fraunhofer ITWM, are being supported.



www.itwm.fraunhofer.de/PR_matbiz-quip



“Decide” Project Wins Nationwide Competition

In the “Digital Places in the Land of Ideas 2023” competition, the project “DECIDE: Digital Counseling, Data Integration, Decision Making and Empowerment” wins in the “Health” category. The project, which is coordinated by the Institute of Medical Biometry, Epidemiology and Informatics (IMBEI) at the Mainz University Medical Center, aims to use digital solutions to provide the best possible healthcare regardless of where people live. Patient data transmitted via an app is analyzed by a system developed at the Fraunhofer ITWM using artificial intelligence.



www.itwm.fraunhofer.de/decide-en

Study: How Realistic Are Pension Products?

A study commissioned by MLP Finanzberatung SE analyzes how high the effective costs of typical old-age provision products are under realistic cost parameters. It shows that the costs resulting from calculations based on the specifications of the Federal Ministry of Finance significantly exceed the realistic costs. Calculations according to the existing legal requirements and calculations of realistic cost rates were compared.



www.itwm.fraunhofer.de/study-pension-insurance



Insights into life with mathematics

Between strong coffee, dedicated project work, exciting online meetings and new algorithms – ARD alpha Uni accompanied our colleague Dr. Tobias Seidel every step of the way in his everyday life at the Fraunhofer ITWM. The video was viewed almost 500,000 times within a year. The Fraunhofer ITWM communications team and the Department of Mathematics at the University of Kaiserslautern-Landau have also captured exciting insights in their own video series “Lautrer Mathe Stories”. More on our Youtube channel.



www.itwm.fraunhofer.de/lautrer-math-story

