

HIGHLIGHTS
2015

ANNUAL REPORT

The online version of the Annual Report and the supplementary section »Names, events, publications« are available at:



[www.iis.fraunhofer.de/
jb2015-en](http://www.iis.fraunhofer.de/jb2015-en)



Reference to further information on the topic



Reference to multimedia content

FRAUNHOFER IIS

The Fraunhofer Institute for Integrated Circuits IIS is one of the world's leading application-oriented research institutions for microelectronic and IT system solutions and services. It ranks first among all Fraunhofer Institutes in size. With the creation of mp3 and the co-development of AAC, Fraunhofer IIS has reached worldwide recognition.

In close cooperation with partners and clients the Institute provides research and development services in the following areas: Audio & Multimedia, Imaging Systems, Energy Management, IC Design and Design Automation, Communication Systems, Positioning, Medical Technology, Sensor Systems, Safety and Security Technology, Supply Chain Management and Non-destructive Testing.

About 950 employees conduct contract research for industry, the service sector and public authorities. Founded in 1985 in Erlangen, Fraunhofer IIS has now 13 locations in 10 cities: in Erlangen (headquarters), Nürnberg, Fürth, Dresden, further in Bamberg, Waischenfeld, Coburg, Würzburg, Ilmenau and Deggendorf. The budget of 130 million euros is mainly financed by projects. 22 percent of the budget is subsidized by federal and state funds.

HIGHLIGHTS
2015
ANNUAL REPORT

We speak with Prof. Heuberger,
Director of Fraunhofer IIS, about
Industry 4.0.



“INDUSTRY IS BEING TRANSFORMED”

A revolution is coming to factories and assembly halls. It goes by the name of Industry 4.0. First factories were mechanized and then electrified, and then IT systems were introduced to support business processes. Now the fourth generation of manufacturing has arrived in the form of Industry 4.0. In this interview, Prof. Albert Heuberger explains what the term means and what Fraunhofer IIS can achieve in this area.

Professor Heuberger, everywhere we turn at the moment we read and hear about Industry 4.0 and the industry of the future. How can we transform this abstract concept into an everyday reality? What does it mean for factory managers and for customers?

Albert Heuberger: The key aspect of Industry 4.0 is intelligence – indeed “smart factory” is another way of saying the same thing. If you look at factories today, many of the production facilities are still “dumb,” processing their tasks in a linear fashion. In the future, things will look completely different. The production machines will network and communicate with one another, share information, make their own decisions, and control themselves autonomously. Even the products will have built-in intelligence. They will always know where they are and know their history, their current status, and the route to their target condition. This has far-reaching implications. It allows production to be more flexible, all the way down to a batch of one. This could ultimately lead to customers designing their products according to their own individual preferences – using an app for instance.

What is Fraunhofer IIS’s position on Industry 4.0?

Albert Heuberger: As a concept, Industry 4.0 is still very young. It only emerged a few years ago. The approaches behind it, however, have been around for much longer. At Fraunhofer IIS, we’ve already been working on these issues for over fifteen years. This includes research into intelligent objects, particularly in logistics. This pioneering work was

also supported by Bavarian state government projects. So Industry 4.0 has a long pedigree at Fraunhofer IIS, and cyber-physical systems are always at its core. Cyber-physical systems are the combination of software and IT with mechanical and electronic parts that communicate with each other – for example, over the internet.

“FRAUNHOFER IIS IS ACTIVE ACROSS THE WHOLE CHAIN: HARDWARE, SENSORS, SOFTWARE, AND CONSULTING”.

Now things are shifting gear: As part of the Bayern Digital program put out for tender by the Bavarian state government, we’ve won a lighthouse project for digital manufacturing. Called “Technologies and Solutions for Digitalized Value Creation”, the project will run for five years. In the project, we are working with our customers to further advance development of the basic technologies required for Industry 4.0, implementing new use cases, and rooting the topic even deeper in the Nürnberg Metropolitan Region. On top of that, there are also a large number of small and large projects carried out with businesses, exploring possibilities such as how to use positioning technologies in industrial applications.

Professor Heuberger, what are the aspects of this that most interest you and your employees?

Albert Heuberger: Industry 4.0 has two sides: the technological and the commercial. Fraunhofer IIS covers both



and – what is more – the entire chain of Industry 4.0. We offer consultation on new vertical applications and business models as well as developing various core components for the required hardware and software.

For example, we've developed basic technologies for wireless identification (RFID), for wireless sensor systems, and for embedded and cyber-physical systems. After all, positioning, identification, navigation, and communication are our core technologies.

Lots of people talk about Industry 4.0 and some have grand ideas – here at Fraunhofer IIS, we have the know-how to implement our ideas. In other words, we're working on the practical realization of Industry 4.0. In this undertaking, we are helped by our industrial network of suppliers, device manufacturers, and users. Which partners are needed to develop new cyber-physical systems along with the corresponding services? We have drawn up 20 different roles that we use as the basis for setting up our network. While one partner creates embedded systems, another looks after the data and service platform, and a third certifies the software. This platform allows us to be very swift and targeted in building up, implementing, and demonstrating new technologies and solutions and translating them into practice.

However, cyber-physical systems alone cannot create added value for entrepreneurs. They have to be embedded in services. In other words, commercial considerations must also be taken into account.

Given that Fraunhofer IIS is primarily an engineering institute, how can you take into account the commercial issues involved in Industry 4.0?

Albert Heuberger: Together with the University of Bamberg, we have founded a competence center for business models in the digital world. The university professors

involved are all drawn from business disciplines. By working hand in hand with these specialists, we can help entrepreneurs to transform their business models and design new services, while providing advice on the technical aspects of Industry 4.0: Which technologies exist in this sector? How can I use them? How do I apply them specifically to my product range?

“WE HAVE THE KNOW-HOW TO IMPLEMENT INDUSTRY 4.0.”

The issue is genuinely pressing: Only four percent of entrepreneurs have already addressed the topic of Industry 4.0 at a closer level. If companies do not wake up and smell the coffee, their products and their businesses could be at serious risk. As a result of digitalization, brand new technologies and services are emerging, which have the potential to significantly change industry boundaries and competition and to render current products and business models obsolete. So it's not just a matter of thinking ahead and trying to anticipate how your own technology will change, but of carefully scrutinizing the alternatives. We're more than happy to help entrepreneurs with our expertise here. However, electronics laboratories are ill suited to the task of demonstrating the benefits businesses can get from our developments. For this reason, we set up the L.I.N.K. Test and Application Center at our site in Nürnberg (Nordostpark). For those who do not know, L.I.N.K. stands for positioning, identification, navigation, and communication. Covering an area of 1,400 square meters, the center allows us to simulate industrial scenarios. The hall is equipped with loading gates, warehouse technology, a lowered outdoor area – we've even bought our own truck that can dock with the hall. In a word, here we can demonstrate our developments to users in a realistic environment.

Which applications can entrepreneurs test there? And which Industry 4.0 applications are conceivable in general?

Albert Heuberger: One broad field I would mention is the Internet of Things. In the IoT, intelligent sensors capture and pre-process information from machines, systems, infrastructure, and products, by means of which they can recognize various statuses and situations. This data is forwarded through cables or wirelessly to a computer or a cloud, where it is analyzed for deviations using special algorithms. In the factory building, the sensors transmit their information via radio up to a distance of some ten meters; in the outdoors area, we achieve considerably greater distances. Our goal is around 30 to 40 kilometers, so that we can cover an entire city and its surroundings.

Non-industrial applications are also conceivable; the possibilities are endless. Although Industry 4.0 is undoubtedly exciting and interesting in its own right, the technologies developed for it can also be used for completely different purposes – such as for navigation systems that guide drivers efficiently to their destinations by avoiding traffic jams, for street lamps that report problems all by themselves, or for home automation technology that does things like control the heating or the blinds. In the field of logistics, there are also all kinds of potential applications.

Through the lighthouse project that has recently got underway, you want to root the topic of Industry 4.0 even more deeply in the region. What role does Industry 4.0 already play for the Nürnberg region today?

Albert Heuberger: The Nürnberg Metropolitan Region is a priority focus for automation technology in Bavaria and in Germany as a whole. Here, Industry 4.0 is already playing an important role. This is facilitated in no small part by the high-performance research environment provided by – among others – the Friedrich-Alexander University

Erlangen-Nürnberg (FAU), the Georg Simon Ohm University of Applied Sciences in Nürnberg, and non-academic institutions such as Fraunhofer. Fraunhofer IIS is engaged with this environment through a series of projects. One example is the Embedded Systems Initiative (ESI) Application Center, which we founded jointly with FAU Erlangen-Nürnberg and where we develop basic technologies for cyber-physical systems, which of course are at the core of Industry 4.0. In this context, Fraunhofer IIS is establishing a new academic chair together with the university. It will conduct research into the technological information systems that cyber-physical systems create – from technological, commercial, and IT perspectives.

Thank you very much for your time.

You can find further information about Industry 4.0 and the Internet of Things on page 8 ff. or online at www.iis.fraunhofer.de/intelligenceofobjects.



www.iis.fraunhofer.de/industrytransformed



8



14



22



34



44

CONTENTS

INTO THE FUTURE

8 The intelligence of objects
The Internet of Things is bringing innovations to manufacturing

34 Combined forces
In the Leistungszentrum Elektroniksysteme (LZE), industry and research are working side by side

AUDIO | MULTIMEDIA

14 Immersed in sound
Taking you there

20 Better sound for streaming and digital radio | Digital radio worldwide | The mp3 Story – the book | AudioLabs: collaboration extended

POSITIONING | NETWORKING | ENERGY

40 OGEMA 2.0 connects energy worlds | Using the maximum capacity of battery cells | Navigating virtual space

SUPPLY CHAINS | SERVICES

42 “20 Years of Fraunhofer SCS” in Nürnberg | Helping design services at JOSEPHS® | Digital picking assistance

IMAGING | SENSORS | MEDICINE

22 Catching the light – Film technology of the future
New methods of post-production through light-field technology

28 Keep-fit fun for all | AVARD – Anonymized video analytics tool | 3D measurement of Earth’s magnetic field from space

NON-DESTRUCTIVE TESTING

44 X-rays in the fast lane
Cost-effective testing technologies for various sectors

DESIGN AUTOMATION

30 Image sensor chip and data processing in one | Short development times for mixed-signal ICS | New specialist for electronics development in Europe

50 Making seals safe | Personnel news | Piano in the CT scanner

52 In brief
62 Figures | Data | Facts
72 Editorial notes

COMMUNICATION SYSTEMS

32 First hardware for DVB-S2X “super framing” developed | LTE testing facility for mobile networks



THE INTELLIGENCE OF OBJECTS

The quality of cleverness is something we generally attribute to people. Now objects are set to become intelligent too – and not just individual smart objects considered in isolation, but as a networked whole. For example, objects will be able to determine their “condition” themselves and “talk” to each other. Researchers at Fraunhofer IIS are developing the basic technologies required for this Internet of Things – and are doing so for the entire chain of applications.

How are you? This is a question only people can answer. In the future, however, objects will also “speak” and tell their user how they are. Effectively, the objects will have a measure of intelligence. So far, so good: but what will all this mean for everyday life? How are we to imagine the Internet of Things on a concrete level? “There are already some applications for the Internet of Things out there,” says Josef Bernhard, who has headed the RFID and Radio Systems group at Fraunhofer IIS for over 17 years. “And in the cities of the future, for example, street lights could send their power consumption values and information about their condition to the relevant municipal body, and garbage cans could tell the municipal waste organization how full they are.”

« RFID
Radio frequency identification

Save 99 percent of energy – with innovative wireless nodes

To help this vision become a reality, Josef Bernhard and his team have developed a wireless communications technology called MIOTY. Of course, it would also be possible for street lights and garbage cans to send information about their condition over the mobile phone

AT A GLANCE

- 1 | The Internet of Things enables objects to recognize and communicate what their condition is.
- 2 | This makes the technology the cornerstone of the industry of the future – Industry 4.0.
- 3 | Fraunhofer IIS develops the basic technologies required for the Internet of Things across the entire chain of applications.

1 The wireless communications technology MIOTY allows garbage cans to automatically recognize how full they are and can provide garbage collectors with an optimized route plan.



network. However, this form of communication consumes a lot of energy, and batteries would not last for long. "Because our wireless node requires only one percent of the energy for transmission that is needed by communication over the mobile network, the battery last a hundred times longer. It will last ten to fifteen years, no problem," explains Josef Bernhard. The range is also impressive: in rural areas, a wireless node fitted to a street lamp can transmit data to a receiver up to ten kilometers away; in the city, it manages two to five kilometers depending on how built up the neighborhood is. The receivers forward the data over the internet to a cloud, where all results are collected and software extracts the essential information out of the data. For example, the software could recognize how full the garbage cans are and create an optimized route plan for the garbage trucks. The wireless nodes themselves are based on standard semiconductor components – what makes them special is how they transmit messages. Instead of bundling the entire information and sending it all as mobile radio does, the researchers divide it up into small packages, which are sent at different frequencies in staggered transmissions. This has several advantages: the transmission is less prone to interference, the energy consumption is lower, and the range is higher.

Researchers at the Fraunhofer Application Center for Wireless Sensor Systems in Coburg are also working on applications for the city of tomorrow. One of the technologies they have been investigating is portable sensor boxes, which collect environmental data such as temperature, air pressure, and UV radiation via a smartphone app. "With our ENSIRO technology, everyone can help to improve knowledge and planning in their city," explains Prof. Thomas Wieland, head of the application center. A customer project is currently underway that monitors consumption points in a building; everyday objects for the most part. This enables items such as coffee vending machines, soap dispensers, and large potted plants to signal when they need to be refilled or watered – saving service staff the trouble of checking them regularly.

Manufacturing facilities that diagnose themselves

Smart cities are not the only area where the researchers at Fraunhofer IIS have much to offer as regards the Internet of Things. In the field of industrial applications, they are also developing various basic technologies to further advance the intelligence of objects. For example, they are developing special algorithms that allow machines and other manufacturing facilities to "feel" when they need repairs or when a component has to be replaced – and then report this immediately to the shift supervisor. In factories today, machines are generally checked at set intervals. Inevitably, however, tools wear down beforehand sometimes – or, conversely, components are replaced as a precaution during maintenance when they would actually last a good while longer. Moreover, each repair is associated with downtime, which must be kept as short as possible. To illustrate what this can mean: if the machines in an

automotive production are idle for just a short while, losses can quickly run into millions of euros. The algorithms developed by scientists at Fraunhofer IIS's EAS Design Automation Division in Dresden are able to ensure that these losses do not occur. "They identify problems before it becomes necessary to take the system offline, thus enabling machines to monitor themselves," explains Dr. Olaf Enge-Rosenblatt, who is responsible for Condition Monitoring Systems at the division.

"ALGORITHMS MAKE PRODUCTION FACILITIES CAPABLE OF LEARNING."

For factory operators, the advantages are clear: they have better control over the risk of breakdowns, need fewer spare parts, and can optimize maintenance planning. For example, they can schedule repairs for a time window in which the consequences of a machine being out of action are less serious. As well as giving production facilities a measure of intelligence, the algorithms also make them capable of learning. Over the course of time, the machines recognize not only that something is going wrong, but can also provide precise indications of what they need.

The Industrial Internet of Things (IIoT) – processes in factories become transparent

When we talk about the Internet of Things for any length of time, then we inevitably get on to the subject of Industry 4.0 – after all, the two topics are virtually inextricable. As Industry 4.0 takes hold, factory workflows will become transparent and products will control their manufacture themselves. That only works, however, if workpieces possess information about themselves and can communicate with other objects and with their environment. This is where the s-net® communications technology developed by researchers at Fraunhofer IIS comes in. "s-net® allows products, for instance, to monitor themselves and to control their manufacture – and to do so energy-efficiently," says Jürgen Hupp, who heads the Communication Networks department at Fraunhofer IIS. "In addition, the individual wireless nodes network with each other autonomously." In everyday terms, that means: if you attach the wireless nodes to a workpiece, they connect autonomously to the network and forward on data recorded by sensors: things such as temperature or vibration strength. However, this is not the limit of the technology's potential by any means: even when it comes to tracking – in other words, determining the position of workpieces on the factory grounds – s-net® provides useful services. Using anchor nodes with fixed positions, the mobile nodes attached to the workpieces can determine where they currently are and send this data to a receiver. In the future, s-net® will even be able to make manufacturing itself easier, as the wireless nodes on products will enable them to become intelligent. For example, s-net® will allow a product

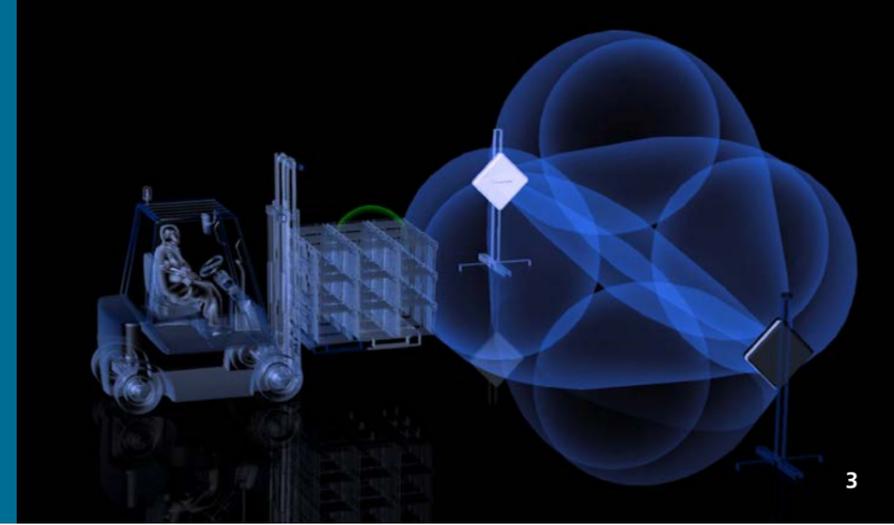
2 Flexible and low-maintenance: flow racks with wirelessly networked s-net® sensor nodes. The display and confirmation buttons make it easy to manage picking orders.

ENSIRO-technology »

Are your coffee vending machines empty or your potted plants too dry? ENSIRO technology records and transmits environmental data and supplies it for evaluation. It is available in portable and installable versions.

« s-net® technology

s-net® is the Fraunhofer technology for extremely energy-saving wireless sensor networks. Its wireless nodes network with each other autonomously. This allows objects fitted with the technology to organize themselves.



Multi-hop communication »

Hopping refers to the forwarding of data from one station to the next. In a multi-hop connection, data is passed on through multiple stations. This makes it possible to cover long distances and large areas and also to circumvent areas with radio interference.

to light up the shelves containing the parts to be fitted when it arrives at an assembly cell. The wireless nodes then know which production step is due and when. Currently the scientists are using s-net® to monitor the condition of cargo in sea containers by means of wireless nodes on the pallets. These nodes network with each other autonomously in the container and deliver the information from the pallet to a telematics box outside the container. As the transmission path from the nodes to the box contains many obstacles, most nodes do not send their data directly to the box, but send it first to other nodes who then forward it. This is sometimes referred to as multi-hop communication.

Logistics goods reveal their identity at entrance to warehouse

The advantages of objects revealing information about themselves and their condition are not restricted to shipping containers, but apply to large warehouses as well. After all, these places are full of hustle and bustle, as one forklift truck after another carries pallets loaded to the brim with goods into the warehouse. Logisticians would love to know at a stroke what is stacked on the pallets without having to unload everything and check. This is hardly surprising: pallets can be loaded with a large number of parts. For this reason, manufacturers provide the individual products with RFID chips. If a forklift drives into the hall, it passes a special gate to which a reader is attached. The reader sends a signal to the chips via an antenna, and the chips “wake up” and send their ID number back. It is a very practical system. However, there has been a recurring problem with RFID chips being so buried and hidden on the pallet that the reader does not get the signal. To remedy this problem, researchers from Fraunhofer IIS have optimized the process: “We’ve replaced the simple antenna on the reader with our innovative multi-beam antenna,” explains Dr. Mario Schühler, whose group researches antenna technologies at the institute. “In the multi-beam antenna, several antennas are effectively merged together, sending out beams in five different directions.” It reads the pallet from the front as it approaches the gate, then from various directions from the side, and finally from the back. This means it can reach RFID chips that conventional antennas would miss and also assign directionality to the objects. Another advantage is that the multi-beam antenna can be used worldwide. Although the U.S., Europe, and Japan all work with different frequencies for reading data, the antenna works for all frequency ranges.

Monitoring and optimizing “object taxis” in factories

Once the products have passed through this incoming control at the warehouse, they are often brought to where they are needed on little tow trains. But which routes should these industrial vehicles take? At what times are there bottlenecks? How can the process be optimized? The positioning technology awiloc® answers precisely these kinds of questions. Small boxes travel on the vehicle and continuously record their location. “The big advantage

of the technology is that it is designed for use with existing structures, making it very easy to install,” says Steffen Meyer, who heads the Cooperative Systems and Positioning group at Fraunhofer IIS. In the case of industrial vehicles, this means: the positioning is based on WLAN, which many companies already have in place. Before the system can get started, the researchers drive the various routes and create a typical signal strength pattern. How strongly are the different stations signaling at which point? Based on this reference data, the system recognizes where the box – and therefore the vehicle – is. The researchers can use awiloc® to record the actual situation. They then work with their colleagues in the Supply Chain Services (SCS) working group at Fraunhofer IIS to figure out how to optimize the journeys.

On October 15, 2015, the positioning technology awiloc® received second prize in the Impact Delivered category at the annual EARTO awards, which have been acknowledging outstanding examples of applied research since 2009. EARTO selects projects with the potential to initiate a transformation in society or business. And that is certainly the case with all Fraunhofer IIS’s developments relating to the Internet of Things. ■

3 Fraunhofer IIS’s multi-beam antennas reliably read RFID tags. Because they are adjustable, they achieve higher reading rates than conventional reading antennas.

« EARTO
This Brussels-based European umbrella organization represents the interests of some 350 research and technology organizations.



[www.iis.fraunhofer.de/
intelligenceofobjects](http://www.iis.fraunhofer.de/intelligenceofobjects)



CONTACT

Karin Loidl
Positioning and Networks division

Phone +49 911 58061-9413
networks@iis.fraunhofer.de

IMMERSED IN SOUND

Fraunhofer IIS has been successfully developing audio coding technologies for many years. The goal of these technologies is to store and transmit audio signals in optimum quality. But what good is having the best audio quality if devices can only reproduce it inadequately? To address this problem, scientists at Fraunhofer IIS have developed the Cingo® and Symphoria® technologies to improve playback sound quality.

3D sound is already in movie theaters near you. But incredibly, listening to 3D sound on cell-phones through headphones will soon be an everyday reality too. Although it might sound like a distant vision or even a pipe dream, it is actually already common practice for users of virtual reality headsets equipped with Fraunhofer technology. And Fraunhofer 3D sound is also providing more realistic music experiences in cars.

To bring big sound to small devices such as smartphones, tablets, and VR headsets and into cars, developers at Fraunhofer IIS have been working in the area of audio coding and audio signal processing for many years. In audio coding, the focus is on reducing the volume of data to be transmitted. Fraunhofer IIS played a major role in developing the best-known examples of this technology: mp3 and AAC. In audio signal processing, the focus is on improving the sound on the respective device.

AT A GLANCE

- 1 | Cingo® allows the reproduction of stereo, surround, and 3D sound through headphones and stereo loudspeakers.
- 2 | With a Symphoria® sound system, all occupants of vehicles experience spectacular surround or 3D sound.
- 3 | Engineers and sound designers work hand in hand on audio signal processing.

1 Fraunhofer Cingo® supplies perfect 3D sound for virtual reality headsets.



2 Increasingly, multimedia content is being played or streamed on mobile devices.

Whether on their smartphones or in home cinemas, users expect best-quality sound

The days when movies, music, and games were consumed only on TV sets or PCs have long gone. Nowadays people consume entertainment on a whole range of devices, such as smartphones and tablet computers, and in their cars. This calls for a seamless crossover between platforms. To give an example: a user might buy a movie on their PC and watch the first half on TV and then watch the rest on the way to work the next morning. In spite of the different video and audio playback systems, buyers expect excellent picture and sound quality on all devices – even though the technical preconditions to make this possible are not always fulfilled. For instance, smartphones have small screens and often poor loudspeakers and cheap headphones. And although cars often feature high-end sound systems, the acoustic conditions inside vehicles are difficult on account of the loudspeaker positions, driving noises, and narrow passenger compartments.

Intelligent algorithms improve sound reproduction

Researchers at Fraunhofer IIS are developing intelligent algorithms to process audio signals, analyze music, and break it up into its constituent parts in order to optimize its reproduction for the specific playback system. For example, the music in a concert hall comes directly from the stage, but also bounces back from the ceiling and the walls. Through the combination of direct sound waves from the stage and reverberant sound, the audience at a concert enjoys a natural and immersive sound experience. If you want to reproduce this experience as closely as possible in a car or over headphones, first the direct and reflected sound waves in the music signal must be identified and separated from each other. Once that is done, the individual elements can be reassembled for playback to form a 3D soundscape that recreates the live concert experience as accurately and faithfully as possible. In this way the listener hears the music as it was originally intended, irrespective of the quality of the actual acoustic environment or whether loudspeakers or headphones are being used. Supporting algorithms balance out weaknesses in the hardware, so that users can enjoy music and other audio content in precise, natural sound quality even over inexpensive loudspeakers or headphones.

Engineers and sound designers work hand in hand

It would not be possible to develop these intelligent algorithms if engineers and scientists did not work closely together with sound technicians and designers. Only by marrying the worlds of sound and technology – and combining their specific know-how – can the optimum sound be achieved for the various playback scenarios. While engineers develop the algorithms for analyzing and processing the audio signals, the specially trained Tonmeisters and sound designers evaluate the sound quality and use the tools provided by the engineers



3 Authentic 3D sound also ensures that tablet viewers feel immersed in the film's soundscape.

Fraunhofer Cingo® brings cinema sound to mobile devices

We are familiar with surround or 3D sound from the movie theater or our home cinema systems. In both cases, a large number of loudspeakers ensure perfect sound. But today most people watch movies on the move on smartphones or tablet computers, which do not have sophisticated sound systems. Yet users still expect an experience that is close to cinema quality. This is where Fraunhofer Cingo comes in: Cingo allows the reproduction of authentic stereo, surround, and 3D sound over the headphones and stereo loudspeakers of smartphones and tablet computers.

When smartphone users, for example, buy movies from a streaming service the soundtrack is typically played back over headphones. But thanks to Cingo this does not necessarily mean having to forego surround or 3D sound experience. Cingo carries out the multi-channel processing directly on the device. Special headphones are not required: the technology is designed to yield optimum results with any type of headphones. As a result, sound effects such as a helicopter passing overhead or rain beating down from above are perfectly reproduced. Moreover, Cingo provides dynamic volume control to improve intelligibility, boosting the loudness of quiet passages of speech and smoothing the contrast between alternating scenes with loud and soft noise levels. This feature also allows spoken dialog to be amplified, which means that the words spoken by movie characters stand out clearly from any sources of background noise – for instance if the viewer is watching the movie on their smartphone in a noisy train station.

Cingo® makes the virtual world audible

Reproducing realistic 3D sound is especially important for virtual reality headsets. This new class of consumer electronics devices allows users to immerse themselves completely in a virtual world. To enter this world, they put on a headset with a built-in video screen or smartphone display and special optical components that give wearers the impression of being in a different environment. However, this first step toward the holodeck featured in the Star Trek universe is only convincing when the 360-degree video images are matched with sound that also seems to come from all directions. After all, if you are looking around in a tropical rainforest, you should be able to hear the birds in the treetops above and not just at head level. This exact localization of sound sources in space via conventional stereo headphones is precisely what Cingo facilitates, making it a perfect technology for all virtual reality



applications. To portray 3D sound as convincingly as possible in the virtual world, Cingo also takes the movements of the head into account. If the VR user turns around, Cingo ensures that the sound image remains fixed in the same place – just as it does in reality – instead of shifting with the head movement as happens with the conventional reproduction of audio signals through headphones.

“CINGO® COMPLEMENTS VR APPLICATIONS PERFECTLY BECAUSE ONLY NATURAL 360° SOUND CAN COMPLETE THE VIRTUAL EXPERIENCE.”

Cingo is already used in numerous devices worldwide. Since 2013, for instance, all devices in Google’s Nexus range feature Cingo. This allows users to play movies that they have bought in the Google Play Store in surround sound on devices. In addition, numerous video-on-demand providers use Cingo in their various apps in order to offer their customers an impressive sound experience even on mobile devices. And last but not least, Cingo is integrated into the Samsung Gear VR, the LG 360 VR and the Hulu VR app.

Fraunhofer Symphoria® creates a harmonious soundscape in vehicles

Whereas the audio effect is often the priority when reproducing surround or 3D sound on smartphones or virtual reality headsets, ensuring that the music reproduction is as natural as possible is essential inside of vehicles. This is why Fraunhofer IIS developed a 3D surround sound technology called Symphoria, which conveys a new sense of spaciousness inside cars. Symphoria expands the soundscape by giving it greater width, depth, and also height. The physical limitations of the passenger cabin seem to disappear. A broad, clearly defined sound stage and a flawlessly balanced surround sound field can be created for each seat in the vehicle. As a result, each passenger enjoys outstanding audio quality, irrespective of whether the sound comes from the radio, a CD, or an mp3 player or whether the audio material is in stereo, 5.1 surround, or 3D audio format. Symphoria creates a harmonious sound pattern for each incoming signal.

Audi is the first vehicle manufacturer to use the Symphoria system. First, the new Audi TT, which features a Bang & Olufsen sound system and Symphoria, was unveiled in the summer of 2014. This was followed by the Audi Q7, R8, and A4 in 2015. In these vehicles, end customers can order the Bang & Olufsen sound system as an optional extra. When they do, they receive a package of around twenty loudspeakers and Fraunhofer Symphoria sound for a unique in-vehicle sound experience unlike anything that has come before.

Symphoria® »
Symphoria ensures that every passenger in a car experiences outstanding audio quality.

Award-winning sound: Joseph von Fraunhofer Prize for Cingo® and Symphoria®

Through its technologies for audio signal processing, the institute is systematically continuing its successful work in the field of audio research. Whereas previously the main focus was on the efficient, high-quality storage and transmission of audio data, Cingo and Symphoria optimize sound for playback on the specific device. As a consequence, Fraunhofer IIS now covers the entire chain from production to reproduction. Using the Sonnox plug-ins co-developed by Fraunhofer IIS, music producers can optimize their music for online distribution. Streaming services and broadcasting companies worldwide use MPEG audio codecs, in the development of which Fraunhofer IIS played a major role, for the efficient transmission of data. And finally, Cingo and Symphoria ensure that good sound is available beyond the confines of living-room hi-fi systems. For this last step, the 2015 Joseph von Fraunhofer Prize was awarded to Oliver Hellmuth, Jan Plogsties, and Harald Popp. ■

4 Harald Popp, Oliver Hellmuth, and Jan Plogsties (from left) were awarded the 2015 Joseph von Fraunhofer Prize for the development and marketing of Cingo® and Symphoria®.

 
[www.iis.fraunhofer.de/
immersedinsound](http://www.iis.fraunhofer.de/immersedinsound)



CONTACT

Matthias Rose
Audio & Multimedia division

Phone +49 9131 776-6175
matthias.rose@iis.fraunhofer.de



BETTER SOUND FOR STREAMING AND DIGITAL RADIO

The audio codec xHE-AAC permits good audio quality even at very low data rates.

Transmitting audio signals on mobile devices requires particularly low data rates in order to achieve high service quality for end customers. As an extension of the AAC codec family, the audio codec xHE-AAC allows speech and music to be encoded in good stereo quality at only 16 kbit/s. This makes it particularly suitable for use in streaming or broadcasting systems. For example, it makes the reception more stable when used on mobile devices. In addition, it improves quality while facilitating lower transmission costs thanks to lower data rates. The first streaming encoder on the market to support xHE-AAC was launched at the IBC trade show in Amsterdam in September 2015. "StreamS Live" from Modulation Index allows every web platform to provide high-quality audio streams. xHE-AAC is already being successfully used in Digital Radio Mondiale (DRM).

As the mandatory audio codec for this digital radio system, xHE-AAC is integrated into numerous transmission systems, chip sets, and receiver units. Thanks to xHE-AAC, listeners of DRM programs enjoy improved sound quality and have a greater variety of stations to choose from. For broadcasters, xHE-AAC makes configuration easier, as the codec supplies consistently good quality for all signal types.

5 xHE-AAC is the codec of choice for music streaming and radio services with low data rates.

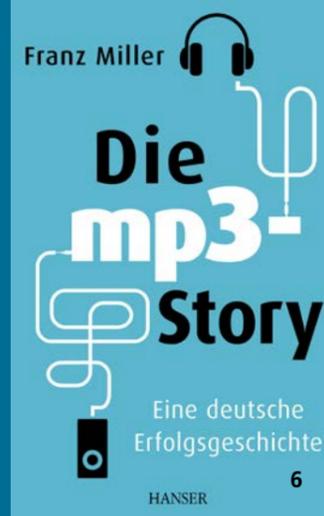
DIGITAL RADIO WORLDWIDE

ContentServer technology has made big contribution to success of digital radio.

Digital radio is in the ascendancy worldwide thanks to new services, better reception, and higher efficiency. The two open standards, Digital Audio Broadcasting (DAB/DAB+) and Digital Radio Mondiale (DRM), in particular are playing a key role in the digitalization of radio. To facilitate the easy and straightforward use of these standards in broadcasting, Fraunhofer IIS developed the ContentServer technology. As a milestone in the implementation of digital radio standards for the general market, it has played a decisive role in the successful establishment of digital radio. For the first time, all components for generating the content transmission signal are united in one device with a standardized, easy-to-understand operating philosophy. This enables broadcasting companies to configure and transmit correct DAB and DRM signals without detailed specialist know-how.

OEM partners are selling the ContentServer technology as part of their products, and the technology is successfully in use. For example, the large digital radio networks in Europe today are operated with ContentServer technology. And the number of broadcasting companies around the world that are using ContentServer technology is also increasing all the time. They include well-known European broadcasters and big-name global players as well as regional and local broadcasters, both public and commercial.

 www.iis.fraunhofer.de/contentserver-en



THE MP3 STORY – THE BOOK

Describing a fascinating chapter in the history of German technology and innovation.

Everyone is familiar with mp3, everyone has mp3 – on their portable media player, smartphone, PC, home stereo system, or car radio. The book "The mp3 Story," which was published in German by Hanser in the summer of 2015, takes us on the technology's long journey from the original idea to global success. Author Franz Miller describes this fascinating chapter in the history of German technology and innovation and shines a spotlight on the people who have shaped it. In impressive studies, Miller also documents how Fraunhofer researchers succeeded in occupying the newly emerging internet market. He debunks some myths and clears up many inconsistencies about the history of mp3. The success of mp3 is unique. Only seldom does technological excellence become such a resounding commercial success. The success, concludes the author, should

6 "Die mp3-Story: Eine deutsche Erfolgsgeschichte"; €26, Carl Hanser Verlag, Munich, ISBN 978-3-446-44471-3

AUDIOLABS: COLLABORATION EXTENDED

Top researchers will be developing pioneering audio and multimedia systems until at least 2025.

In September 2015, Fraunhofer IIS and Friedrich-Alexander University Erlangen-Nürnberg (FAU) agreed to continue their partnership within the joint collaboration of International Audio Laboratories Erlangen. In this unique joint institution, audio and multimedia technologies have been very successfully researched and developed since 2010. Initially, the collaboration was planned for ten years. The early contract extension for an additional five years underscores the importance of this unique alliance, creates certainty in planning, and strengthens the cooperation between the two partners. Now the work in the AudioLabs can be continued until 2025 at the minimum. The cooperation of researchers from around the world with employees of Fraunhofer IIS has paid off over the past few years. For example, there have been contributions to the new 3GPP mobile communications

codec EVS and to the 3D audio standard MPEG-H Audio. In addition to research and its implementation in applications, teaching is one of the main priorities of the AudioLabs. Training a new generation of scientific talent ensures that research quality remains high and bolsters innovative thinking and scientific progress.

  www.audiolabs-erlangen.de

7 AudioLabs contract extended by 5 years: (from left) Prof. Alexander Kurz, Executive Vice President of Fraunhofer-Gesellschaft; Dr. Florian Janik, Mayor of Erlangen; Prof. Albert Heuberger, spokesperson for AudioLabs, Director of Fraunhofer IIS; Prof. Joachim Hornegger, President of FAU Erlangen-Nürnberg; Dr. Sybille Reichert, Chancellor of FAU Erlangen-Nürnberg.



CATCHING THE LIGHT – FILM TECHNOLOGY OF THE FUTURE

Shooting is finished. During post-production, errors are discovered that had previously gone unnoticed. With light-field processing, this is no problem. The technology offers new possibilities for film production and allows scenes to be modified.

The scene is in the can. The film crew has packed up its cameras, rails, floodlights, and monitors. The actors are already on the next set. All takes are safely stored on digital media and are ready for post-processing and editing. The director and cameraperson inspect the material and select the scenes for the initial rough cut together with the editor. It is precisely here that issues come to light which, for all the meticulous planning, create new doubts in the cold light of the screening room and post-production. Did the camera really travel correctly during the tracking shot? Were there little wobbles and lack of focus in there that should not be in the final cut? When working with one or two cameras, this often means that nothing can be changed, because it would be too expensive and too much effort.

Changes are possible even after shooting

This is exactly where light-field technology comes in, a new kind of tool for recording and above all for post-production. The technology uses a variety of different perspectives, which are recorded on set with multi-camera systems, to alter and creatively adapt sequences. For example, the perspective of a scene can be changed, the depth of field can be shifted, and effects such as virtual tracking shots can be subsequently integrated. All this, of course, has long been everyday practice in studios for computer-generated scenes. In the Moving Picture

AT A GLANCE

- 1 | With light-field technology, multiple views of a scene are recorded in a single take.
- 2 | The various views of the scene allow effects like virtual tracking shots and changing the angle of vision and focus.
- 3 | Fraunhofer IIS's algorithms are used to create efficient depth maps as the basis for further processing steps.

1 Fraunhofer IIS's technology saves the entire light information for a scene, as symbolized here in the picture by the goalkeeper cradling the illuminated ball.



2

Technologies department at Fraunhofer IIS, scientists have been working for many years on the application of light-field technology for use in live-action movie scenes. The head of the department, Dr. Siegfried Foessel, and his colleague Dr. Frederik Zilly are fascinated by the technological and creative challenges that a practically viable solution entails. “The starting point for our considerations about how expensive, time-consuming pick-ups and re-shoots could be avoided and how unrepeatable scenes could be used in new film versions were topics in our many discussions with our customers and partners in the film industry in Germany, Europe, and Hollywood,” recalls Siegfried Foessel. “Increasingly, it was the cost and also the generally unsatisfactory results when merging real scenes with virtual, digital effects that drove the search for a solution.” The scientist’s team has been working together closely with the technological and creative side of the film industry on the transition to digital technology since 1998. One of the first digital film cameras to be suitable for practical application, the ARRI D20/21, was developed in the laboratories of his engineers, as was the internationally used easyDCP post-production software, as he proudly explains while looking at the screen in the in-house cinema.

Creating films with easyDCP »
easyDCP software makes it easy
to create, play, and encrypt
digital cinema packages in line
with the relevant standards on
any computer. Over 1500 post-
productions use this software to
bring DCPs to the big screen.

3D as catalyst for new technology

Meanwhile, Frederik Zilly and his team are presenting the first production-ready test versions for post-production tools for light-field and multi-camera recordings. A physicist by training, Zilly has been working on camera set-ups for 3D and special effects since 2007. He has been looking for a way of combining various levels of an image or various views of a scene with each other as efficiently as possible in order to create new scene views. “For multi-camera recordings, the so-called depth maps that have to be calculated for each scene are decisive,” explains Zilly excitedly. “You need them to be able to generate virtual views in high quality. This procedure is extremely time- and labor-intensive in most cases, and it harbors multiple sources of potential errors. However, depth maps are an absolute prerequisite for effects such as rack focuses, virtual tracking shots, and combining reality and virtual effects. On today’s film sets, there is more than just one main camera in use. Using the variety of recordings and views of these cameras for creative post-production work is where light-field technology and light-field processing come into play.”

Light field – a century-old technology conquers 21st century film sets

The technique of recording all rays of light in a scene and not only those that strike the lens of the main camera is not actually a new approach – it is just that digital and synchronizable technology has made it feasible. The French scientist Gabriel Lippmann worked on light field from as early as 1908. “In purely mathematical terms, you define a light field by means of a function which describes the quantity of light that falls on each point of a three-dimensional

space in all directions,” explains Frederik Zilly as he scrutinizes graphs and point clouds on his office monitors. “With the autostereoscopic monitors that allow users to watch 3D movies without special glasses – and whose popularity is quickly spreading, particularly in the high-resolution 3D sector – you need to generate an extremely high number of views of a scene, the more the better. The more complete the number of views, the freer viewers are to change position in front of the screen without perceiving gaps or blurring in the picture.”

2 The goalkeeper watches the recording. Thanks to light-field technology, you can choose freely in post-production whether, for example, you want to change the perspective or the focus.

“THE CHANGE OF PERSPECTIVE IS THE STAR ATTRACTION OF LIGHT-FIELD TECHNOLOGY.”

Based on these experiences, results were also used for shooting live-action movie scenes. To illustrate, Frederik Zilly points to a mini-scene with Lego figures in his studio, which is used for stop-motion films. Holding 16 HD cameras in a 4x4 array, the stand does not move. After a pre-processing step to synchronize the cameras, all 16 individual recordings are inspected and synthesized. Next, intermediate views are generated, and the scenes are color-matched. Embedded in a professional post-production tool, various adjustable effects now appear via a plug-in. With a few simple maneuvers (which actually conceal a large number of sophisticated algorithms) Zilly shows how he can shift the focus from the front to the back without making any adjustments to the settings of the lenses. The star attraction, he explains, is the change of perspective. Conventional post-production software usually relies on zooming to simulate a virtual tracking shot. By contrast, the Fraunhofer IIS software calculates a real parallax from the various views, creating the impression of an actual dolly shot. This is particularly important for situations in which objects or people are close to the viewer as they move past. To give a specific movie example, let us say that a car driver sees a pedestrian on the near sidewalk while driving past. If the apparent change in position of the pedestrian is not taken into account when the driver changes his or her own position while driving past, we perceive the situation as jarring and unrealistic. It is precisely these kinds of possibilities and effects that make light-field technology appealing for productions that use green screens to prerecord complex scenes for subsequent use. Light-field methods allow pre-produced scenes to be adapted directly to the recordings in front of the green screen. Nowadays this happens only with faraway scenes in order to minimize the disruptive effects. Using light-field technology and intelligent algorithms, it becomes possible to select close-up scenes as well.

First pilot clip in conjunction with Stuttgart Media University

In conjunction with Stuttgart Media University, Frederik Zilly has already tackled real pilot productions. With the help of students, a pilot clip was recorded using a camera



What is a mirror rig? »

Several cameras simultaneously record a movie scene from the same perspective through a semi-transparent mirror, whereby one camera films the reflection while the others look through the mirror.

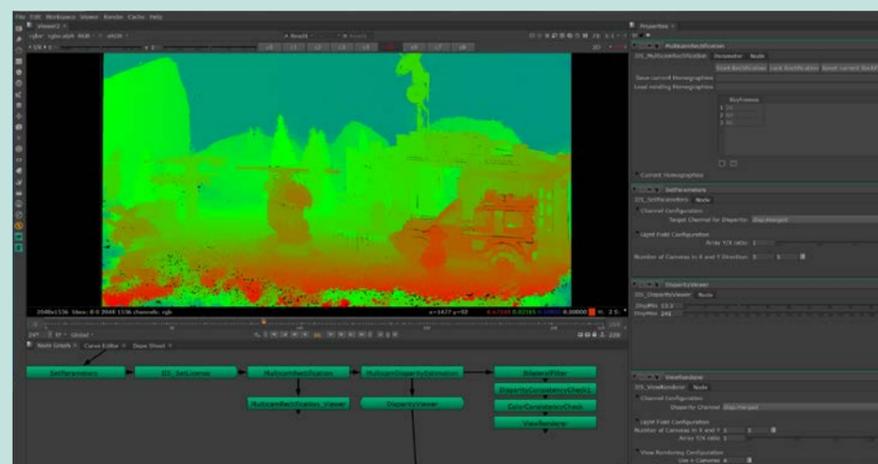
configuration made up of nine HD cameras and a high-resolution cine camera on a mirror rig. Processing of the scenes and post-production were carried out subsequently using the tools developed by Frederik Zilly and his team. The result was a clip called Coming Home, which featured real actors, various special effects, green screen recordings, and additional virtual objects, all of which put the performance of the algorithms through their paces under the tough real conditions of an ordinary film set. Particularly impressive was the efficient creation of depth maps, which allowed students to make depth-based color corrections in post-production. As a result, they could make precise adjustments, such as changing only

is always used as a complement to one of the main cameras. Accordingly, a pure light-field movie is unlikely ever to happen,” explains Siegfried Foessel. However, Zilly and Foessel both expect that light-field technology will blossom into a serious new processing method in movie and TV production over the next three to five years. To be continued! ■

3 Scene in a stop-motion test setup for developing light-field algorithms.

Program package for post-production of light-field recordings

The licensable plug-in suite for NUKE allows users to create depth maps for purposes such as the calculation of virtual tracking shots and depth-dependent color design.



the background colors and lighting. Moreover, relighting – a step that permits further light sources to be subsequently added to a scene and for the lighting of a scene to be edited, including side effects such as shadows, reflections, etc. – is also possible thanks to light-field algorithms.

A look into the future

Light-field approaches hold huge potential for the future of moviemaking. Although the technology is still in its infancy as regards professional motion pictures, influential producers and cinematographers are taking an ever keener interest. “As one of the first developers and providers of professionally usable software, we’ve attracted lively interest,” says Siegfried Foessel. “More and more productions are making inquiries about possible collaborations with us to create the first pilot productions. In this way, they want to play a role in advancing the technology.” How long will it be before the first production using Fraunhofer technology is shown on our TV screens or in movie theaters? “Multi-camera or light-field technology



CONTACT

Dr. Frederik Zilly
Moving Picture Technologies department

Phone +49 9131 776-5154
frederik.zilly@iis.fraunhofer.de



www.iis.fraunhofer.de/
catchingthelight



KEEP-FIT FUN FOR ALL

IT-based fitness game helps people with disabilities to practice their motor skills.

There are lots of fitness games out there. Now scientists at Fraunhofer IIS together with partners in the akrobatik@home project, which is sponsored by the German Federal Ministry of Education and Research, have developed an adventure fitness game and various assistance systems for physically disabled people. The video game develops stamina, coordination, and concentration while also stimulating motor skills.

Scientists at Fraunhofer IIS's Image Processing and Medical Engineering department developed a smart shoulder pad as an important control element for the fitness game. The experts integrated numerous sensors that record the movements of the player's upper body. Vertical, horizontal, and rotating movements are all captured by the sensors. The player uses these movements to control an avatar in the fitness game. Their movement data is transmitted via Bluetooth, processed, and then transferred to the avatar in the game. The big advantage is that the game motivates patients to do their exercises much more frequently than without this stimulus.

All the developers in the project have involved the people that will subsequently use the technology in the design process from the beginning. Thalidomide victims were willing to share their strategies for managing everyday life in order to help with the development of suitable technical assistance systems.

The high levels of acceptance for the fitness game in the user group are also motivating the researchers. As the next steps, they will incorporate the sensors unobtrusively into clothing and also make the fitness game available for other platforms.

 www.iis.fraunhofer.de/fitnessspiel-en

5 Working together with thalidomide victims and research partners, Fraunhofer IIS has developed a fun IT-based fitness game.

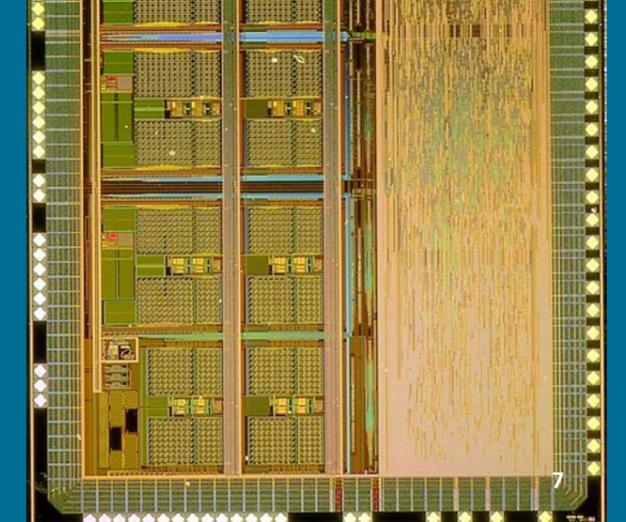


AVARD – ANONYMIZED VIDEO ANALYTICS TOOL

Intelligent sensor transmits anonymous metadata for retailers.

In the online world, advertisers and the operators of sales platforms have numerous ways to analyze customer composition and behavior. By contrast, bricks-and-mortar retailers and the operators of digital billboards and posters often know a lot less about their customers.

To compensate for this lack of knowledge, Fraunhofer IIS has developed AVARD (Anonymous Video Analytics for Retail and Digital Signage). The basis of the system is SHORE™ – a software solution for anonymous facial analysis that can recognize the age, gender, and facial expression of people and groups of people in real time. This eliminates the need for transmitting video data and analyze it on a computer. Because only metadata and statistics are transmitted, absolute protection of privacy is guaranteed.



3D MEASUREMENT OF EARTH'S MAGNETIC FIELD FROM SPACE

Analysis electronics are a thousand times more sensitive than a compass.

In March 2015, four identically instrumented satellites from NASA's Magnetospheric Multiscale (MMS) mission were launched into space from Cape Canaveral in order to investigate the protective magnetic layer around the Earth and measure tiny changes in the Earth's magnetic field with high precision. Particular development challenges included the temperature stability requirements and the high reliability and robustness necessary against ionizing cosmic radiation.

Working together with the Austrian Academy of Sciences' Space Research Institute in Graz, Fraunhofer IIS was able to develop a highly integrated electronic evaluation circuit that meets these specific requirements. The integrated circuit was developed for a digital fluxgate instrument that allows the Earth's magnetic field to be measured in 3D. Capable of

As Wolfgang Thieme, head of the Digital Camera Systems group explains: "With AVARD, Fraunhofer IIS is supplying an advanced tool for anonymized video analytics. As well as benefiting retailers through improved customer analysis, it also benefits customers by protecting their privacy."

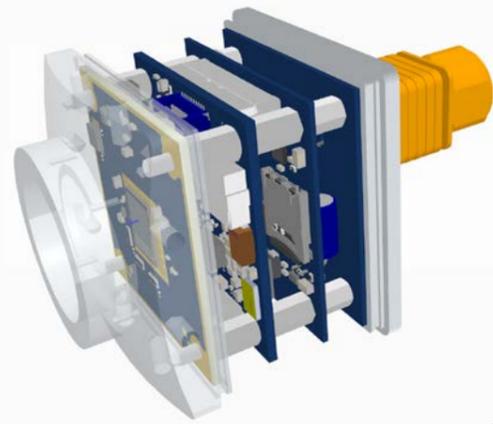
 www.iis.fraunhofer.de/avardanalyse-en

6 AVARD recognizes the gender and age of customers and transmits anonymized metadata.

recording tiny magnetic fields with a resolution of 10 picotesla, the measurement system is several thousands of times more sensitive than an electronic compass. The four satellites travel around the Earth in a highly elliptical orbit, which means they cover areas both close to and further away from the Earth. Evaluating the magnetic field data will keep researchers in fundamental science busy for decades.

 www.iis.fraunhofer.de/erdmagnetfeld-en

7 Layout of integrated circuit for highly sensitive magnetic field measurement in space.



1

IMAGE SENSOR CHIP AND DATA PROCESSING IN ONE

Vision sensor records and processes data.

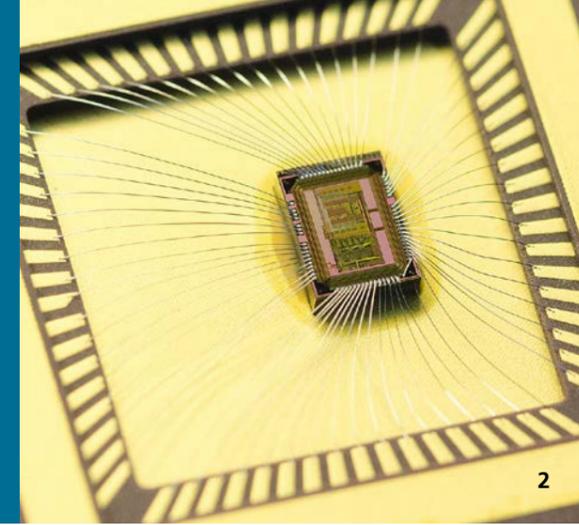
Image processing systems have to meet ever higher requirements for industrial applications. To ensure that these systems have a wide range of possible applications, researchers at the Design Automation Division EAS of Fraunhofer IIS have developed a general-purpose, flexibly programmable image sensor chip that also looks after data processing. This Vision-System-on-Chip – or vision sensor for short – was unveiled to a worldwide expert audience at the International Image Sensor Workshop in June 2015.

The sensor is particularly suitable for cameras that are used for automated tasks requiring minimum temporal delay, high refresh rates, or a wide dynamic range. This is where it has clear advantages over conventional image processing systems.

The very high-performance solution is based on highly parallel image processing and built-in sample extraction. Compute-intensive processing steps are carried out directly in the sensor, which allows output data to be kept to the relevant minimum. The Vision-System-on-Chip processes complex algorithms at high speed and simultaneously guarantees high sensitivity and a wide dynamic range. In the integrated software, parameters such as precision, resolution, and sampling rate can be set individually for an application's requirements in addition to the image processing algorithms. This unparalleled combination opens up a wide variety of fields of application for the vision sensor – from real-time production monitoring to the detection of people.

 www.eas.iis.fraunhofer.de/aktivitaetserkennung-en

1 The Vision-System-on-Chip is fully integrated in the camera.



2

SHORT DEVELOPMENT TIMES FOR MIXED-SIGNAL ICS

Intelligent IP design flow accelerates design of analog components.

Integrated circuits with digital and analog parts – mixed-signal ICs – are present in countless products today. Although the analog part usually makes up no more than 20 percent of the chip surface, it drives up the costs of the IC, because of the low automation level of design processes during its development. This problem is becoming more acute with the increasing miniaturization taking place in semiconductor technologies. "Intelligent IP Design Flow," which was developed at the Design Automation Division EAS, offers a unique degree of automation, especially for analog design, which otherwise tends to be very time-intensive and error-prone. In several development projects, design engineers were able to demonstrate that efficiency could be increased significantly using the Intelligent IP Design Flow. Johann Hauer, head of Mixed Signal ASIC Development at

Fraunhofer IIS, explains: "Time savings of 40 percent for a specific design project together with high design certainty – what that means is that we can finally offer first-time-right designs with much shorter development times." Customers who have commissioned Fraunhofer engineers to develop mixed-signal ASICs and IPs are already reaping the benefits – in 2016, they will be able to apply Intelligent IP Design Flow directly for themselves.

 www.eas.iis.fraunhofer.de/iipdesignflow-en

2 The high-resolution A/D converter will be available to companies in 2016.

NEW SPECIALIST FOR ELECTRONICS DEVELOPMENT IN EUROPE

The spin-off COSEDA Technologies provides software for ultra-modern microchips.

One in every two microchips that are manufactured in Europe comes from Dresden. "Here we can cater for the special requirements and wishes of our European customers particularly well. This is an important niche in a market dominated by big American companies," says CEO Karsten Einwich as he explains the decision about where to base the newly founded COSEDA Technologies GmbH. "In addition, we have our former employer behind us, with whom we will also collaborate closely in future," continues the engineer. The company started business on July 1, 2015. Comprising former employees of the Design Automation Division EAS at Fraunhofer IIS, the team provides software that allows companies to develop particularly complex electronic products faster, more reliably, and more cost-effectively. This is enabled by a technological platform with an especially

broad functional scope for the design of technical systems consisting of analog and digital components, and of hardware and software. The COSIDE® design software developed at EAS plays a major role in this. Containing various modeling and simulation technologies, the software allows companies to carry out secure and effective virtual advance testing of products before they are even manufactured.

 www.eas.iis.fraunhofer.de/coseda-en

3 Founding members of COSEDA Technologies GmbH: (from left) Thomas Arndt, Thomas Hartung, Karsten Einwich, Dominic Scharfe.



3



FIRST HARDWARE FOR DVB-S2X "SUPER FRAMING" DEVELOPED

Wideband transmission via satellite is set to become faster and more efficient.

"We have developed 'super framing' for the new DVB-S2X transmission standard and we're the first to possess compliant hardware," explains Christian Rohde, senior scientist at Fraunhofer IIS. "This allows us to use the full bandwidth of a satellite channel more efficiently while simultaneously reducing signal distortions."

The starting point for the development was the insight that demand for satellite communication is increasing all the time and that it would be very useful to transmit more data more quickly. However, this has to be achieved with limited bandwidth resources. Thanks to the signal structuring developed using "super framing," interfering signal distortions are reduced, more efficient use is made of the full bandwidth of a satellite channel, and more flexible and robust transmission methods can be developed.

In addition, scientists at Fraunhofer IIS and partners have established a testbed for the complete DVB-S2X wideband transmission chain, whereby "wideband" refers to a signal bandwidth greater than 100 MHz. This end-to-end transmission chain provides a bandwidth of 500 MHz and covers all aspects: from applications (IP trunking, broadband and UHDTV transmission), encapsulation, signal modulation, channel simulation, and receiver signal processing, and all the way back to applications again, so that an ordinary 3D/HD television, for example, can show the transmitted video programs.

"Our testbed is a big attraction for our customers," explains Rohde. "We can simulate real transmission situations and conditions in our measuring environment. This allows us to thoroughly test and optimize the entire transmission chain from the sender to the receiver under realistic operating conditions."

 www.iis.fraunhofer.de/dvbs2x-en

1 Growing volumes of data are being transmitted via satellite. For this purpose, Fraunhofer IIS is providing new high-performance hardware.



LTE TESTING FACILITY FOR MOBILE NETWORKS

Fraunhofer IIS sets up LTE-A test bed for new mobility and IoT applications.

Digital data traffic is constantly growing. In addition to smartphones, now notebooks, netbooks, e-books, digital cameras, and video cameras can also send and receive data. The mobile communications technology LTE is designed primarily for these devices. LTE stands for Long-Term Evolution.

LTE is the world's first globally valid wireless communication standard for Europe, North America, and Asia and represents a further development of UMTS and HSPA. The wireless broadband technology offers users significantly higher transmission rates, better network coverage, a more stable connection, and higher speed. LTE-A (LTE Advanced) counts as the fourth generation of mobile telecommunications technology and builds on the existing LTE standard. In cooperation with Nokia, Fraunhofer IIS has set up an LTE-A test bed in Erlangen, where companies can test new services and applications for the Internet of Things and for connected mobility.

Over an area of up to 500 square kilometers and using state-of-the-art LTE-A technology, companies can test how applications or data transmissions behave under certain mobility criteria and situations, such as under various utilization rates of the cellular network. In contrast to commercial networks, Fraunhofer IIS's LTE-A network is run as an open testing and measurement facility.

The network contains two sites, each with three macro cells, where services such as LTE broadcasting (eMBMS) can be tested in a real environment with off-the-shelf commercially available devices. Fraunhofer IIS operates the network itself, while Nokia Networks supplies the requisite base stations (eNodeB). The base stations can be equipped with Mobile Edge Computing technology, which makes it possible to execute time-critical and broadband-hungry applications locally at the station instead of sending the data through the cellular network first.

How does that benefit users? Whereas simple LTE can convey data from the internet to subscribers at a maximum of 150 Mbit/s, LTE-A will be able to reach transmission rates of up to 1 Gbit/s. The high-speed networks can supply more subscribers with high-data-rate services, and downloads of large files are completed sooner.

 www.iis.fraunhofer.de/ltetestbed-en

2 Fraunhofer IIS in Erlangen offers companies the use of an LTE test bed with coverage of up to 500 square kilometers and LTE-A technology.



COMBINED FORCES

The course is set: now the Leistungszentrum Elektroniksyste (LZE) (High Performance Center for Electronic Systems) is embarking on its mission to establish itself as the leading center for electronic systems in Germany. Energy saving and energy efficiency – this strategic collaboration between research and industry is focused on nothing less than these key economic and social topics of the future. Something is happening at the heart of the Nürnberg Metropolitan Region about which others can only dream: world-class research with a well-defined practical orientation.

Thursday, November 19, 2015. The Leistungszentrum Elektroniksyste (LZE) hosts its first Tech Day. High-level visitors have registered for the event in large numbers: some 100 representatives of industry and business – from medium-sized companies to global corporations – have turned up. Among the crowd are representatives from big-name industrial companies, leading automotive manufacturers and suppliers, internationally renowned manufacturers of sporting goods, automation technology manufacturers, small energy technology businesses, and companies from the textile industry. “What we show our partners and potential customers at the Tech Day is targeted world-class research with a well-defined practical orientation,” explains Prof. Dr. Albert Heuberger, Director of Fraunhofer IIS in Erlangen.

Showcasing mature prototypes

At the Fraunhofer Institute for Integrated Systems and Device Technology IISB, Prof. Dr. Heuberger and the Director of Fraunhofer IISB, Prof. Dr. Lothar Frey, jointly lead a tour

AT A GLANCE

- 1 | The LZE conducts research into new kinds of low-power electronics and pioneering power electronics.
- 2 | High-tech with a practical edge: During the pilot phase, the LZE has €15 million in funding to work with.
- 3 | Excellent showcase for electronic systems: The inaugural Tech Day in November rounded off the LZE's first year.

1 In the Leistungszentrum Elektroniksyste (LZE), research and industry are pulling together.



2 LZE project “Low-Power Electronics for Sports and Fitness Applications”: Scientists are developing an advanced prototype for vital signs and movement data out of the T-shirt. The T-shirt simultaneously records positional and movement data as well as vital signs such as ECH and respiration data.

through a small but excellent exhibition. At four stands, researchers from both Fraunhofer institutes and the University of Erlangen-Nürnberg proudly present the mature prototypes of their current LZE projects. “They are our lighthouse projects,” says Professor Frey with a satisfied smile. “They demonstrate that our teams can tackle complex electronic systems with a unique range of expertise.” Total initial investment for the LZE amounts to €10 million and comes in equal parts from the Bavarian Ministry of Economic Affairs and the Fraunhofer-Gesellschaft, while a further €5 million comes from joint projects with industry.

“TARGETED WORLD-CLASS RESEARCH WITH A WELL-DEFINED PRACTICAL ORIENTATION”.

Standing at one of the stations is project manager Dr. Nadine Lang, who holds a PhD in biophysics. The monitor on the table shows the data curves for various vital signs. Beside the monitor lies a white T-shirt. Lang explains what makes the FitnessSHIRT special: “We’ve developed a new method of measuring and recording various health data using smart textiles.” Anyone who sets out on a run or hops on a bike to meet their fitness target for the day is familiar with the dilemma: a device attached to a tightly fitting measurement harness shows the pulse rate, but is the breathing rate OK too? Does the heartbeat actually change with the physical exertion? “Thanks to the sensor electronics integrated in the FitnessSHIRT, the pulse, breathing activity, and movement intensity can be simultaneously recorded, evaluated, and displayed on an app,” explains Nadine Lang, who enjoys climbing and cycling in her free time. Now the project team under Nadine Lang has combined the FitnessSHIRT’s sensor technology with the radio-based real-time positioning technology RedFIR®, which was also developed and subsequently refined at Fraunhofer IIS. This means that the shirt can record positional and movement data at the same time as ECG and breathing. In addition, the scientists have developed new kinds of algorithms that enable users to interpret and analyze ECG signals, such as heart rate variability. Nadine Lang explains: “As a result, you can do things like ‘track’ a whole soccer team in real time. Coaches receive a package of useful data for every player.” Yet “Low-Power Electronics for Sports and Fitness Applications” is just one technological field in which researchers at the Leistungszentrum Elektroniksysteme (LZE) are continuously working.

A pioneering collaboration that acts as a beacon

In January 2015, the LZE began its two-and-a-half year pilot phase. The joint initiative between the Fraunhofer-Gesellschaft, its two Erlangen-based institutes Fraunhofer IIS and Fraunhofer IISB, the Friedrich-Alexander University Erlangen-Nürnberg (FAU), further non-academic research institutions, Siemens, and other partners from industry is a pioneering



collaboration that acts as a beacon. “We see the LZE as a pioneering model for the Nürnberg Metropolitan Region,” says Professor Heuberger. “We’re building on longstanding, fruitful collaboration between the Fraunhofer institutes and the university and are also using the unique concentration of research and industry in the field of electronic systems in the Nürnberg-Erlangen-Fürth triangle.” Such exceptionally favorable circumstances do not exist anywhere else in Germany. Without complex electronic systems, future high-tech applications are inconceivable – whether in automotive manufacturing, in plant engineering, or in automation, energy, medical, or health technology. The commercial potential is huge precisely when – as with strategic collaborations such as the LZE – the focus is on clever solutions for smart power grids, medical engineering, electromobility, Industry 4.0, or energy efficiency. Working together with industrial partners, the LZE has big ambitions: “We want to generate traction beyond the Nürnberg Metropolitan Region and to attract national and international attention,” says Professor Frey. Accordingly, Frey stresses that the High Performance Center for Electronic Systems is “much more than just a large-scale collaborative project.”

Major topics of the future

The LZE is specialized in the key economic and social topics of the future: energy saving and energy efficiency. Full of passion and ingenuity, the center is taking a twin-track approach from the start. On the one hand, it is developing new types of low-power electronics designed to minimize energy consumption. Examples include the sophisticated technology in the FitnessSHIRT and in other sport and fitness applications. Other scenarios involve equally clever solutions for energy-saving integrated circuits and energy-efficient data transmission in complex communication networks, as required, for example, in Industry 4.0. On the other hand, the LZE’s activities are also focused on coming up with pioneering power electronics for applications such as powertrain technology and the future energy supply – so that electrical energy can be converted and distributed efficiently and cost effectively. An example of this is “Wireless Power and Data Transfer in Systems with Fast-Moving Parts,” a project that hardly anyone knows better than Thomas Heckel. On a yellow-painted, industrial-use robotic gripper arm, Heckel points to a thick wiring harness that winds along the robot axis from the base all the way to the tip of the gripper arm. “It’s all pretty cramped, as you can see. Classic industrial robots are unable to turn flexibly in order to screw, weld, or record measurement values, because the wiring harness is in the way. That’s a drawback for manufacturing.” Furthermore, the cable harness weighs up to 40 kilograms, which causes the movement of the arm to be unbalanced. But how do you make the power supply cheaper, the data transmission more reliable, and the entire electronic system smaller and more compact? “Our vision is to get rid of the cables and to develop a functional inductive technique for energy and data transmission.” And this is precisely what the project manager and his team

3 LZE project “Wireless Power and Data Transfer in Systems with Fast-Moving Parts”: The goal of the project is the inductive – and therefore contactless – transfer of energy together with data transmission in fast-moving components.

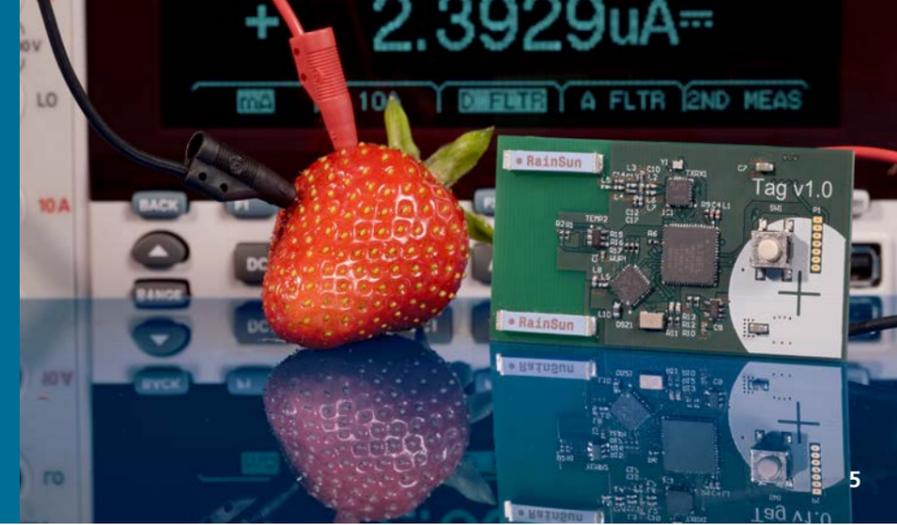


4 LZE project “DC Backbone with Power-to-Gas Coupling”: Energy for the future – scientists are researching a new system for energy storage.

have achieved. An induction transmitter coil only 7 millimeters thick is fitted in the gripper arm along with a ball bearing. The electronics required is smaller than a matchbox and can be tucked away neatly in the robot’s base. “I was fascinated by the idea of bringing a long-known, conventional technology such as induction to a completely new application and at the same time creating something new,” says Thomas Heckel. “We’ve brought the power electronics to a certain degree of maturity,” he emphasizes self-confidently. “Now we want to introduce them into practice.” He and his team have already begun to develop the technology for an inductive plug connection. Sturdy wireless plugs could be used in any situations where dirt or oil could incapacitate electrical contacts, such as in food production and in the chemical industry. The plugs could also be used in construction and agricultural machinery, such as when a tractor and a trailer have to be electrically connected. “Electrics allow much faster steering and controlling than when using a traditional mechanical power take-off drive.” Taking these projects by Dr. Nadine Lang and Thomas Heckel alone, we see clearly how close the LZE has situated itself to practical application. “The projects highlight both the opportunities and the necessity of this approach, which is also what industry wants and expects,” says Professor Heuberger. “There is huge commercial potential in the LZE,” he adds. “We have lots of application ideas for our technologies and of how we can implement them with our partners,” says Professor Frey.

Enthusiastic feedback from business and industry

At the LZE’s first-ever Technology Day (or LZE Tech Day for short), the enthusiasm shown by representatives from business and industry for the ideas was very palpable. For example, the product and innovation manager of a leading automotive supplier wanted “to get up to speed with the latest technology and intensify our current cooperation with Fraunhofer.” An industrial manager for innovation electronics judged the pilot projects presented as “very promising approaches to pursue new markets.” The excitement involved in realizing something new is also tangible in the two other LZE projects, such as “DC Backbone with Power-to-Gas Coupling” headed by Bernd Wunder. This project seeks to answer the following big questions: In the context of the energy transition and the growing scarcity of fossil fuels, how can we secure our energy requirements? And how can self-produced energy be stored cost effectively and on a major scale? Fraunhofer scientists are all too aware that lithium-ion batteries, which can hold only a limited amount of energy, are not the only solution. This is why they are collaborating with the Friedrich-Alexander University Erlangen-Nürnberg (FAU) to research coupling techniques that use a chemical carrier in liquid form. Known as a liquid organic hydrogen carrier (LOHC), it securely binds the alternative energy carrier – hydrogen – like a sponge. By means of a fuel cell, the hydrogen can then be converted back into electrical energy. This method can be used to store excess energy in summer and then release it during the winter heating period. Or it can be used to balance



out load fluctuations in the power grid. Last but not least, there is the “Energy-Independent Asset Tracking System for Logistics Applications” project, which focuses on extremely power-saving electronics solutions that are needed to make the Internet of Things possible. Using the example of a high-performance logistics application, the team of researchers led by Dr. Heinrich Milosiu has developed a special low-maintenance positioning system, which allows goods in a warehouse or in outdoor areas to be located and tracked. The researchers show how spectacularly little power this radio-based solution consumes by means of a somewhat surprising demonstrator: a glowing red strawberry repurposed into a battery. Even such a weak and simple “strawberry battery” is capable of powering the wireless receiver. Therefore, the electronics used in the logistics tags – on which the data is stored – boasts very low power consumption: under ten microamperes in fact. The researchers are already working on further reducing power consumption down to just one microampere.

Short route from basic research to application

What the LZE defines as “research in new dimensions” is not just an integrated approach to rethinking joint electronic systems research, but is also about shortening the route from basic research to industrial applications. Ideas are already being developed for how to achieve this and what the next steps should be: research structures designed along the lines of think tanks, special investment and development teams, and new high-tech start-up business models. In any event, the bright minds at LZE have already developed technologies that – as Professor Albert Heuberger puts it – “will influence people’s lives today, tomorrow, and in the medium term”. ■

5 LZE project “Energy-Independent Asset Tracking System for Logistics Applications”: Power-saving wireless receivers – so-called wake-up receivers – require only a thousandth of the power that an LED needs.



www.iis.fraunhofer.de/combinedforces

Further information:
www.lze.bayern/en



CONTACT

Dr. Christian Forster
Group Manager Business Development and Innovation

Phone +49 9131 776-1066
christian.forster@iis.fraunhofer.de



OGEMA 2.0 CONNECTS ENERGY WORLDS

Secure “adapter” for communication interfaces and devices in energy management.

No plug fits every power outlet in the world – not even in the energy world of the future. Every manufacturer offers their own communication interface programmed in different languages. For this reason, Fraunhofer IIS is developing OGEMA 2.0 – a sort of “adapter” for energy management devices and systems. OGEMA 2.0 stands for Open Gateway Energy Management 2.0 and is a flexible and hardware-independent framework that is based on Java and for which apps can be created. Thanks to its modular structure, OGEMA 2.0 easily and flexibly establishes interoperability between the individual communication media that are supposed to work with each other. Applications, graphic displays, add-ons, and improvements can be swiftly implemented as required.

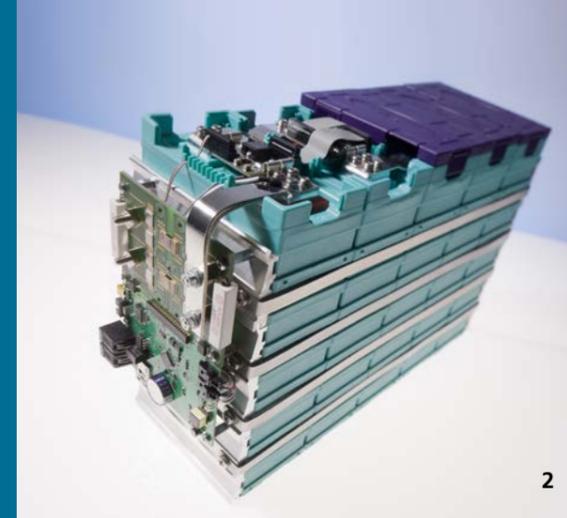
Fraunhofer IIS is developing an adaptable security concept that permits the security level to be adjusted in stages to match the specific requirements. The lowest level is suitable for simple single-user installations in the consumer sector. It contains individual access privileges for the apps. The next security level supports multi-user systems for industrial applications and building complexes. Because the apps generate data per specific user group and this data can be displayed and evaluated only by authorized users, different people can use the same app without being privy to each other's data.

OGEMA 2.0 is ideally suited to smart energy management in buildings. In this framework, components such as solar collectors and batteries and smart devices and applications can be perfectly integrated and contribute to enhancing living comfort and optimizing energy flows. In Industry 4.0 applications, it helps record the consumption of individual machines and systems and allows factories to reduce energy costs and meet the requirements of energy audits. In addition, it acts an interface for machines in the Internet of Things.



www.iis.fraunhofer.de/ogema-en

1 Intelligent framework for energy management systems and Industry 4.0.



2

USING THE MAXIMUM CAPACITY OF BATTERY CELLS

FlexBMS increases the lifetime of batteries for stationary energy storage units and electric vehicles.

The flexible battery management system FlexBMS extends the lifetime of batteries in a wide range of applications. Examples include stationary energy storage units for use in domestic households or electric vehicles. Working with partners, the Integrated Energy Supplies group develops customized solutions for the safe, long-lasting, and efficient use of battery cells. Through the active balancing of charge differences, the maximum capacity of each individual battery cell can be efficiently used. For electric powertrains in e-cars and hybrid vehicles, supply voltages of up to several hundred volts are required. Lithium-ion batteries have cell voltages of 3.7 volts or lower, which means that several battery cells have to be connected electrically in series. To operate all cells within the recommended and safe voltage and temperature ranges and to charge them



3

evenly, the battery management system monitors all the individual cell voltages and cell temperatures. In addition, it provides precise information about the remaining battery charge and the maximum capacity available. Together with maintenance-free battery technology, FlexBMS ensures that domestic systems for storing renewable energy enjoy longer service lives.

www.iis.fraunhofer.de/batteriemanagement-en

2 FlexBMS monitors all of a battery's cell voltages and temperatures.

NAVIGATING VIRTUAL SPACE

Precise positioning helps people find their way in simulated worlds.

Virtual reality (VR) allows people to immerse themselves in new and unfamiliar scenarios and worlds. It offers benefits and opportunities that industry, architects, and urban planners are increasingly using to assist them in planning and design. This requires an enhancement of VR that takes it away from desktop applications and into large open or enclosed spaces. To make this possible, VR systems must contain high-performance, precise positioning technology. Only with a positioning system is it possible to track the movements and interaction of several people and objects in large simulated indoor and outdoor areas such as warehouses and manufacturing complexes. The more precise the positioning, the more realistic the VR simulation seems to users. Just such a positioning solution has been devised based on the RedFIR® system developed at Fraunhofer IIS. Using wireless

radio technology, it precisely scans positional data at a rate of up to 2,000 positions per second. Even when masking effects are present, the system is reliable compared to optical methods. This allows factors influencing the subsequent design of buildings and processes to be interactively tested and experienced during the planning phase. The cost-intensive building of models is no longer needed. Based on this VR implementation using positioning technology and smart sensor fusion, scientists at Fraunhofer IIS are also working on systems in the area of games, sports, and fitness.

www.iis.fraunhofer.de/virtualreality-en

3 Up, down, right, or left? Positioning technology helps.



"20 YEARS OF FRAUNHOFER SCS" IN NÜRNBERG

"Faces and Visions" was the theme for the big anniversary celebration.

Founded under Prof. Peter Klaus as the Application Center for Transport Logistics and Communications Technology, even in the early days logistics meant much more to Fraunhofer SCS than just "transport, handling, and storage". This conception, which explicitly encompasses the entire value creation process, has been continuously further developed since then. As a consequence, Fraunhofer SCS now successfully combines business know-how with logistics, technology, and service expertise.

This success was recently celebrated. On November 25, 2015, some 250 invited guests attended Fraunhofer SCS's anniversary evening "Faces and Visions" at the Air Campus in Nürnberg. The title of the event was well chosen, as partners, alumni, and employees had the opportunity to get to know – and sometimes rediscover – through digital and analog technology, and also live, the people that shaped – and indeed continue to shape – Fraunhofer SCS throughout its history.

A particular highlight was when Prof. Peter Klaus, co-founder of the working group, and Prof. Dr. Alexander Pflaum, a longstanding associate, took a look at the past and the future of logistics for the benefit of the guests. Prof. Klaus told some anecdotes that looked back on the characteristics that make Fraunhofer SCS unique and related them to the main developments in logistics that happened under his watch. By contrast, Professor Pflaum cast a light on the future, presenting the principal megatrends that have the potential from Fraunhofer SCS's perspective to significantly change logistics over the next few years. Accordingly, when considering the near future of logistics at Fraunhofer SCS, special attention will be given to the topics of digitalization and growing service orientation. These aspects were present in all the trends presented by Professor Pflaum. Mastering them is the necessary prerequisite not only for dealing with the growing complexity of managing the supply chain, but also achieving the breakthrough that will transform such activities into a key production asset capable of fundamentally changing the logistics market.

 www.scs.fraunhofer.de/en

1 Some 250 guests celebrated "20 Years of Fraunhofer SCS" in Nürnberg.



HELPING DESIGN SERVICES AT JOSEPHS®

The open laboratory for service research celebrates one year of successful work.

Almost 150 visitors celebrated the first birthday of the service manufactory. Guests included Dr. Michael Fraas, economic adviser to the city of Nürnberg, Prof. John Bessant from the University of Exeter, who traveled to the event with a piece of music he composed himself, and the research companies already represented in JOSEPHS®, such as Amoonic, Jaimie Jacobs, and bewegtbild+. In JOSEPHS®, visitors can try out product and service innovations in a playful context and work with partners to shape and design them based on the visitors' own ideas until they are ready for market launch. By November 2015, the open innovation laboratory had already welcomed 13,000 visitors as co-developers. Since February 2016, everything has been about "Fitness & Save Mobility." From May, the theme will be "Experience, Travel & Vacation," and from August it will



be "Interaction between Humans & Technology." Through training and corporate workshops on the subject of service design, JOSEPHS® has already established two new business education services in the Nürnberg Metropolitan Region and beyond. In the "School Class" project, 600 pupils recently adopted the role of entrepreneurs and developed their own ideas and business models. In addition, numerous companies use JOSEPHS® for workshops to help them and their employees to think outside of the box.

  www.josephs-service-manufaktur.de/en/the-concept

2 At JOSEPHS®, visitors can test and further develop current concepts proposed by companies.

DIGITAL PICKING ASSISTANCE

Wireless, self-organizing sensor networks simplify the manual collection of goods.

In manual picking, Pick-by-Light (PbL) systems have light displays on the storage spaces to help workers collect orders correctly. However, established wired and wireless PbL systems only meet the requirements for flexible, labor-saving picking to a limited extent. They are either time-consuming to install or have low battery lives. The goal of the current Pick-by-Local-Light (PbLL) research project by the Fraunhofer Center for Applied Research on Supply Chain Services SCS and the Fraunhofer Institute for Integrated Circuits IIS is to develop a new kind of picking system based on wireless sensor networks. s-net® technology for extremely energy-saving, wireless, self-organizing sensor networks permits the easy installation of automatic control systems for displaying the relevant compartment on racks and shelves. With the technology, temporary storage structures and the fast

modification of storage spaces and racks pose no problem. If pickers carry a wireless sensor node on them, site-specific picking functions are possible, such as signaling that limits itself to the aisle in which the picker is standing. PbLL is energy-efficient and low-maintenance. The PbLL research project is sponsored by the German Federation of Industrial Research Associations (AiF) and an industrial consortium.

 www.iis.fraunhofer.de/pbll-en

3 Flexible order picking thanks to s-net® technology.



X-RAYS IN THE FAST LANE

X-ray technologies are excellently suited to the task of revealing even tiny defects or processes inside materials. To provide industry with suitable tools, the Development Center for X-ray Technology (EZRT), a division of Fraunhofer IIS, defines and expands the state of the art in the field of non-destructive testing all along the product life cycle. Over the past year, researchers at the center have published many innovative new concepts. The researchers are especially proud of two new technologies: “HeiDetect Inline CT Compact R” and “MULIX”.

“HeiDetect Inline CT Compact R” tests components in the production line

A clear trend is emerging in the automotive industry: lightweight construction is the name of the game and it is one of the basic prerequisites for the competitiveness of German car manufacturers. To make vehicles lighter – and therefore more efficient – virtually all components have to be slimmed down. Of course, this slimming must not reduce safety, which is monitored via component testing. From a purely technological point of view, it has been possible for many years to test components even in the production line. However, most of these inline computed tomography systems are not yet commercially viable. The investment costs for these solutions amount to a high six-figure sum. Additional costs for direct integration into the process chain further elevate the investment to dizzying heights. Working together with the company Erhardt + Abt, researchers at the Development Center for X-ray Technology have therefore developed a new system concept that works very efficiently and cost effectively: “HeiDetect Inline CT Compact R”. One of the outstanding features of this

AT A GLANCE

- 1 | The EZRT develops technologies for non-destructive testing along the entire product life cycle.
- 2 | “HeiDetect Inline CT Compact R” tests objects reliably in the production line and saves both time and money.
- 3 | X-ray detector “MULIX” displays images from inside materials virtually live.

1 EZRT X-ray technologies test the insides of components in record time, ensuring their safety and quality.

NON-DESTRUCTIVE TESTING
X-RAYS IN THE FAST LANE



2 The centerpiece of “HeiDetect Inline CT Compact R” at work: An industrial robot lifts a component from the production line and places it in the completely radiation shielded box for testing.

3 This CT image of a cast aluminum part shows exactly the defects in the component. The technology can locate these defects and determine whether they are critical in terms of the manufacturer’s quality specifications.

compact system is its greatly simplified component handling. An industrial robot combines aspects of the manipulator and loading systems, removing the need for many additional individual components.

CT images delivered in seconds

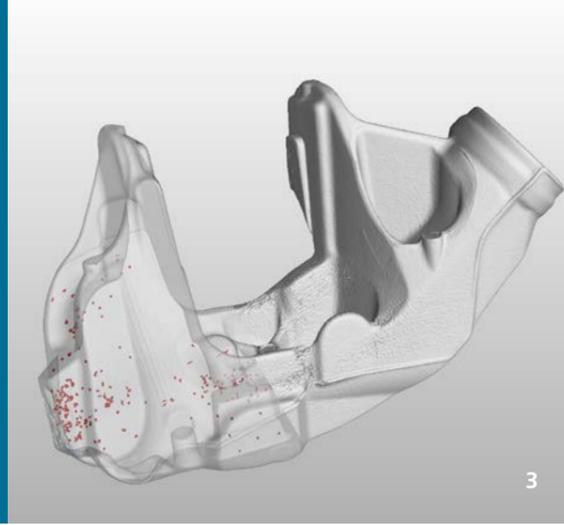
The system works in a way that is simple and effective in equal measure. Located next to the production line that conveys the objects to be tested is the box of the inline CT system. An adjacent industrial robot lifts a component from the production line, places it in the completely radiation shielded box, and rotates it 360 degrees. While the component is rotating, the X-ray components installed in the box create highly informative CT images in a matter of seconds. These images make it possible to clearly identify, locate, and evaluate defects. Specially developed algorithms effortlessly compensate for slight inaccuracies in the robot’s movement, ensuring that image quality is up to the required standard.

“THE RADIATION SHIELDING IN ‘HEIDETECT INLINE CT COMPACT R’ IS AROUND 60 PERCENT MORE COMPACT, WHICH SAVES SPACE AND REDUCES COSTS.”

Whereas meter-high cladding was required for the systems used to date, the radiation shielding in the new system is considerably less voluminous. Compared to commercially available production-integrated CT systems, the shielding is some 60 percent more compact. This saves space and reduces costs. In addition, it cuts maintenance and repair costs significantly. With the “HeiDetect Inline CT Compact R,” the Fraunhofer researchers are striking out on new paths and showing that research does not have to be complicated. As well as saving time, unnecessary components, and valuable space, the system does what it is supposed to: it carries out reliable inline component testing.

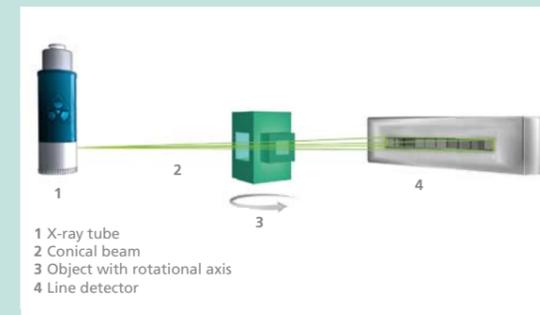
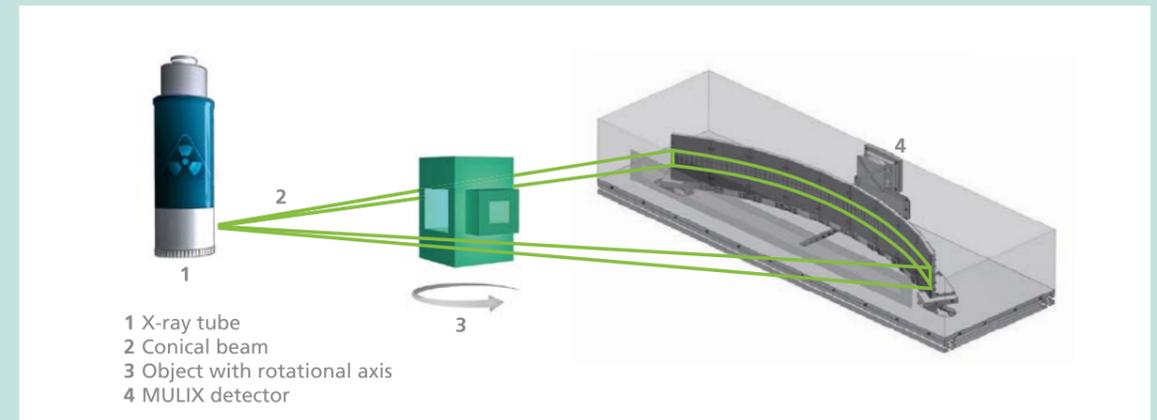
MULIX – Live images from inside materials

Detectors play a key role in X-ray systems. They are responsible for capturing the X-rays penetrating the test object. To date, flat-panel and line detectors have been used for industrial testing. Now researchers at the Development Center for X-ray Technology have found a way to combine the advantages of these two detector types in a single hybrid detector. This allows even processes taking place inside materials to be precisely traced and observed almost live. The ambitious technology is called MULIX (multi-line CMOS X-ray detector).



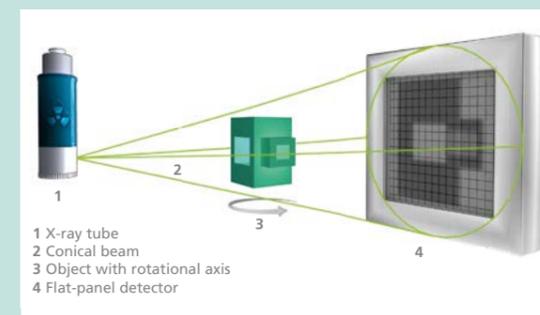
MULIX detector

The MULIX detector is a hybrid solution that combines the flat-panel and line detector technologies currently used by industry. It unites high speed with high image quality. Its modular design facilitates maximum flexibility.



Line detector

In line detectors, the scattered radiation (the rays deflected by the test object) is reduced. As a result, they deliver pin-sharp images. However, only a small layer of the object is captured at a time, which makes scanning time intensive.



Flat-panel detector

Although flat-panel detectors quickly supply 2D imaging of the entire object, scattered radiation impairs the image quality. In addition, flat-panel detectors are available only up to a size of approx. 40x40 centimeters, which limits the maximum object size to around 30 centimeters in diameter.



More lines for better imaging

The detector is based on multi-line detector technology – a concept that has been limited to medical applications until now. Multi-line detectors work according to the same principles as line detectors, but they can cover greater areas simultaneously, which significantly reduces imaging times. Because MULIX is capable of imaging 256 object layers simultaneously, it can quickly and efficiently scan even large objects such as car body parts. What makes the detector so special is that it supplies high-quality images very quickly. Unlike commercially available detectors, the radius of curvature can also be changed. This maintains the flexibility required for industrial computed tomography in order to adapt the system to the size and material characteristics of the test object.

Processes inside materials become visible

MULIX opens up a whole range of new possible applications in materials research and quality assurance, such as in the automotive and aerospace sectors and for research institutions, because it allows processes taking place inside materials to be observed. “When we test mechanical characteristics – let’s say tensile strength for example – we can use the images to track how a failure-relevant defect arises,” explains Thomas Hofmann, researcher at the Development Center for X-ray Technology. The scientists already have concrete plans for their project: “We’re looking for industrial partners to further develop MULIX into a prototype,” explains the head of the department involved, Dr. Norman Uhlmann. ■

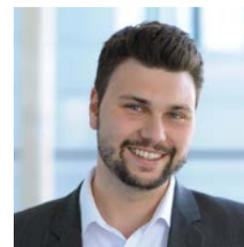
Development Center for X-ray Technology: the entire product life cycle

The Development Center X-ray Technology (EZRT) is a division of Fraunhofer IIS, Erlangen, in cooperation with Fraunhofer IZFP, Saarbrücken. It carries out research in the fields of system development, X-ray sensors and simulation, computed tomography, imaging, CT-assisted measurement engineering, applications, and training. The center is a leading international research and development facility for industrial X-ray technology. It defines and expands the state of the art in the area of non-destructive testing, particularly with regard to optical and X-ray testing technologies. In addition, it positions itself between a focus on basic research in the field of non-destructive imaging (X-ray and optical techniques) and industrial applications with end customers (in the form of prototypes) and with system integrators (via licensing). The EZRT possesses core competencies in the area of non-destructive testing along the entire product life cycle, all the way from raw materials to recycling. To strengthen the competitive position of regional, national, and international industry and to open up new markets and application possibilities, the Development Center for X-ray Technology devises application-oriented solutions that extend to the manufacturing of prototypes and small-scale series.

4 The main building of the Development Center for X-ray Technology, which was built at the Fürth site in 2013, houses a range of different X-ray systems and is unique in the world for the broad variety of systems available.



[www.iis.fraunhofer.de/
inthefastlane](http://www.iis.fraunhofer.de/inthefastlane)



CONTACT

Thomas Kondziolka
Development Center for X-ray Technology

Phone +49 911 58061-7611
thomas.kondziolka@iis.fraunhofer.de



5

MAKING SEALS SAFE

“Seal Inspector” tests polymer sealing rings using laser lines.

Without noticing it, people come into contact with these unspectacular looking and easy to construct plastic parts on a daily basis. We are talking about polymer sealing rings. They play an important role in many areas of our lives, above all in our vehicles. For example, they are fitted in air-conditioning units and in braking systems, where their role is generally to ensure that no liquids leak out. Whereas the consequences of a faulty seal in an a/c unit are easy to deal with, the failure of a seal inside a braking system can pose more serious problems.

To objectively and reliably detect even tiny surface defects, researchers at the Development Center for X-ray Technology have worked with the company “miho Inspektionssysteme” to develop the “Seal Inspector” testing system, which meets the requirements of industry from the points of view of both cost effectiveness and the technology itself.

The centerpiece of the testing system, which was developed by Fraunhofer researchers, consists of a high-resolution measuring unit and evaluation software specially developed for this application. The measuring unit records the surface of the sealing rings from all sides in 3D. This is achieved by projecting several laser lines onto the different sides of the sealing ring and recording their paths on the ring using special cameras. From this measurement data, the evaluation software reconstructs the entire surface and, in a subsequent step, securely detects all relevant anomalies. Initial testing systems based on this system concept have been successfully integrated in production, demonstrating the suitability of this technology for the rapid, precise surface testing of goods that are mass-produced in their millions. The measurement principle used in the technology opens up a wide range of possible applications whenever there is a need for rapid, high-resolution surface testing.

5 The system for rapid and precise surface testing is fully automatic.



6

PERSONNEL NEWS

Dr. Norman Uhlmann and Dr. Steven Oeckl take up new positions.

On July 1, 2015, Dr. Steven Oeckl, former head of the “Algorithmics” group, took over the reins of the “Inline Testing Systems” department at the Development Center for X-Ray Technology in Fürth, which has now been renamed “Production Monitoring.” The main focus of the department’s activities is on the development of in-line monitoring systems designed to reduce rejects and scrap. This leads to greater resource efficiency, enabling capacity to be increased while consuming the same amount of energy and raw materials. Apart from strengthening customers’ competitiveness, this also benefits the environment.

Also on July 1, 2015, Dr. Norman Uhlmann, head of the “Application-Specific Methods and Systems” department, took up his new duties as acting director of the Development Center for X-ray Technology in Fürth.

6 Acting director Dr. Norman Uhlmann (left) and head of department Dr. Steven Oeckl.

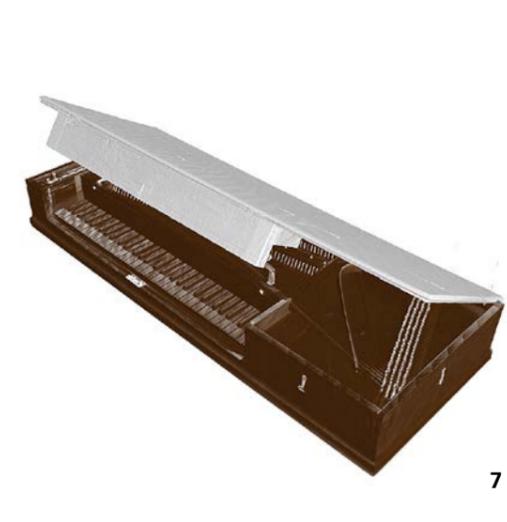
PIANO IN THE CT SCANNER

Fraunhofer creates standard for 3D X-ray analysis of musical instruments.

Interesting cooperation has been taking place between the Development Center for X-ray Technology, the Germanisches Nationalmuseum (GNM), and the Chair of X-ray Microscopy (LRM) at the University of Würzburg. Since November 2014, these institutions have been carrying out research as part of the MUSICES project, which is funded for three years by the German Research Foundation (DFG), in order to develop guidelines and procedural methods for the 3D computed tomography of musical instruments. Project researchers are creating robust, well-founded guidelines that will form the basis for international standards in order to ensure that image quality can be reliably compared. The variety of musical instruments that will be covered by the guidelines and specifications to be developed is drawn from the GNM’s comprehensive collection. A few kilometers

down the road, the impressive range of X-ray systems at the Development Center for X-ray Technology in Fürth – a collection that is unique in the world – provides the ideal conditions for generating geometrically accurate volume data. Meanwhile, there are facilities for carrying out basic physical research and supporting imaging or analytical methods for reconstructing and evaluating volume data at the LRM in Würzburg and also in the various developer groups at the Development Center for X-ray Technology.

7 This peek inside a square piano from 1787 reveals previously invisible details.



7

IN BRIEF

On the following pages, you will find out what else happened in our institute in 2015 aside from research progress. We have compiled a selection of notable events for your reading.

2 Welcoming the second construction phase of the ESI Application Center:
(from left) Dr. Ronald Mertz from Bavarian Ministry of Economic Affairs and Media, Energy and Technology;
Prof. Dr. Albert Heuberger, Director of Fraunhofer IIS;
Thomas von der Grün, Co-Director of the ESI Application Center;
Prof. Dr. Jürgen Teich, Co-Director of the ESI Application Center;
Prof. Günter Leugering, Vice-President of FAU Erlangen-Nürnberg;
Dr. Klemens Gsell, Mayor of Nürnberg.

30 Years
IIS
IISB

1



2

30 YEARS OF FRAUNHOFER IIS AND IISB

1985–2015: The Erlangen Fraunhofer institutes celebrate their birthday.

Together, the Fraunhofer Institute for Integrated Circuits IIS and the Fraunhofer Institute for Integrated Systems and Device Technology IISB form one of the most successful sites in the Fraunhofer-Gesellschaft today. The two institutes were founded in 1985 with significant input and funding from the Bavarian Ministry of Economic Affairs and Transport as it was then known. Subsequently, the two institutes turned themselves into strong partners for business by developing their own research interests. Fraunhofer strengthens the Nürnberg Metropolitan Region by leveraging synergies and through close ties to industry. As well as providing hundreds of high-tech jobs, the Fraunhofer institutes also supply business with excellent know-how and highly qualified employees. Fraunhofer IIS and Fraunhofer IISB are outstanding innovators in the fields of microelectronics,

power electronics, IT and communications technology, and semiconductor technology. Their latest joint initiative is the High Performance Center for Electronic Systems, which was launched in 2015 together with the Friedrich-Alexander University of Erlangen-Nürnberg and industrial partners. To celebrate the anniversary, the institutes published a brochure and special web feature called "30 Highlights." The publications provide an overview of the successful work and broad expertise of Fraunhofer IIS and Fraunhofer IISB.

 <http://blog.fraunhofer.de/30years>

1 30 years of top-class research
in the Nürnberg Metropolitan
Region.

CENTER FOR EMBEDDED SYSTEMS FIRMLY ESTABLISHED

The ESI creates the basis for the digital revolution in industry and mobility.

The ESI Application Center for embedded systems is entering its second construction phase. €6.3 million in funding is being provided by the Bavarian Ministry of Economic Affairs and Media, Energy and Technology for this stage for the years 2015-2018. The joint initiative by the Friedrich-Alexander University of Erlangen-Nürnberg and Fraunhofer IIS is now being established as an institution that will further the industry-oriented development of embedded systems in its role as an interface between industry and research. Embedded systems are a key component driving progress in application-related research in the automotive, fitness, and automation sectors, particularly as regards the digitalization of business and manufacturing processes. Following pilot and transfer projects in the first phase, the successful collaboration is now being cemented in the establishment of

the ESI Application Center. Over the past few years, for example, basic developments have been realized in the embedding of wireless and communications technology and translated into small compact radio sensors. These miniature smart electronic systems are becoming increasingly important in digitalized manufacturing, for future mobility concepts, and in sport and fitness applications. They are fundamental components for the constantly growing complexity of industrial requirements. To this end, the ESI Application Center carries out projects such as the development of new sensor and camera systems for driver assistance systems. In these projects, the researchers create the ideal foundation for the key technologies of the future.

 www.iis.fraunhofer.de/esi-en



A HAVEN FOR RESEARCH

The campus in Waischenfeld is a retreat for Fraunhofer scientists.

From now on, Fraunhofer employees can research, develop, and have conferences in a community-style work environment in the region of Bavaria known as Franconian Switzerland. On May 11, 2015, Fraunhofer IIS officially opened the Waischenfeld Research Campus together with Ilse Aigner, Bavarian State Minister of Economic Affairs and Media, Energy and Technology, Stefan Müller, Parliamentary State Secretary to the German Federal Minister of Education and Research, and Prof. Alfred Gossner, Executive Vice President of the Fraunhofer-Gesellschaft.

“Our employees’ ability to think creatively is an important component of the institute’s success,” emphasized institute director Prof. Albert Heuberger at the inauguration ceremony for the facility. The research campus is a place where Fraunhofer employees can retreat with customers, cooperation partners, or as a team in order to concentrate on making solid progress on projects. Office and laboratory rooms covering 320 square meters and seminar rooms covering 250 square meters of floor space provide a creative environment for concentrated, effective work. The large seminar room can host conferences of up to 150 people. Thanks to the modular building concept, the campus can be used by groups of different sizes.

The verdict of Ilse Aigner, Bavarian State Minister of Economic Affairs and Media, Energy and Technology, was as follows: “The new research campus is the best proof that top-class non-university research is taking place in all corners of Bavaria. The beauty of Franconian Switzerland in combination with the Fraunhofer IIS’s typically excellent facilities creates a perfect working environment. In Waischenfeld, there is the right atmosphere for successful, project-related scientific work.”

Meanwhile, Stefan Müller, Parliamentary State Secretary to the German Federal Minister of Education and Research, had the following to say: “The Waischenfeld Research Campus stands for the enduring success, the richness of ideas, and the innovation focus of IIS within the Fraunhofer family. And it’s also a particularly successful example of the close interconnection of business and science.”

3 At the opening of the Waischenfeld Research Campus: (from left) Prof. (Univ. Stellenbosch) Dr. Alfred Gossner, Executive Vice President of the Fraunhofer-Gesellschaft; Stefan Müller, Parliamentary State Secretary to the German Federal Minister of Education and Research; Ilse Aigner, Bavarian Minister of Economic Affairs and Media, Energy and Technology; Prof. Dr. Albert Heuberger, Director of Fraunhofer IIS.



DEMONSTRATING ENERGY HARVESTING IN CHANCELLERY

Chancellor Angela Merkel visited the institute’s stand at Girls’ Day to learn about energy harvesting.

Generating electricity from body heat – this was something Chancellor Angela Merkel and pupils from three Berlin schools were able to try out in the Chancellery on Girls’ Day. In this form of energy harvesting, the temperature difference between the human body and its immediate environment is used to generate electrical energy. This energy is sufficient to power various sensors in a wristband along with a wireless Bluetooth connection for communication. Only the presence of the voltage converter from Fraunhofer IIS makes this possible. The converter works even for the tiniest thermovoltages, and therefore for the smallest temperature differences at the thermogenerator, and converts them into larger output voltages. “Our technological goal is to create maintenance-free, wireless systems with unlimited operating times and service lives independently of external energy



supplies or batteries,” explains Dr. Peter Spies, head of the Integrated Energy Supplies group at Fraunhofer IIS. As one of two guest institutes of the Fraunhofer Group for Microelectronics, Fraunhofer IIS presented the thermoelectric generator and the BlueTEG self-powered sensor wristband.

  www.iis.fraunhofer.de/energyharvesting-en

4 Chancellor Angela Merkel learned from Heiko Wörlein, Fraunhofer IIS, how electricity is generated from temperature differences.

DISCOVERING RESEARCH

Science Campus gives young women an insight into work at Fraunhofer.

Fraunhofer’s Science Campus is an ideal springboard for women in science and research. Some 50 students and graduates were hosted by Fraunhofer IIS in March 2015. They were students in their fourth semester or higher in the disciplines of science, technology, engineering, and mathematics, the so-called STEM subjects. The visitors gained a deep insight into the application-oriented research work at the Science Campus, designed to help them take the plunge into a successful career in research. At Fraunhofer IIS and at the Energy Campus Nuremberg, they got to know possible careers in the field of microelectronics. At the Waischenfeld Research Campus, they were able to attend further education seminars covering topics such as Time Management, Job Application Training, The Power of the Voice, Design Thinking, Career Paths, and Self-Assertion

in your Professional Life. The Science Campus is an event run by the Fraunhofer-Gesellschaft – this year in cooperation with the Fraunhofer Institute for Integrated Systems and Device Technology IISB, the Fraunhofer Institute for Environmental, Safety and Energy Technology UMSICHT, and Fraunhofer IIS – and takes place twice a year at various locations in Germany.

 www.iis.fraunhofer.de/karriere-en

5 In the sound laboratory, participants were introduced to new audio technologies.



SUCCESSFUL LONG NIGHT OF THE SCIENCES 2015

Visitors gained insights into everything from new sound worlds to X-ray vision.

A large variety of exhibits and presentations could be enjoyed by the roughly 3,000 guests who attended the Long Night of the Sciences 2015 at Fraunhofer IIS. The event is organized by Kulturidee GmbH every second year. Across the entire metropolitan region, research institutions and companies open their doors and answer visitors' questions. With over 40 program events, Fraunhofer IIS was one of the main partners of the Long Night. In addition, the institute hosted the opening ceremony with over 300 invited guests. Close encounters with research and researchers awaited the visitors to Fraunhofer IIS in Erlangen and the Development Center for X-ray Technology at the Fürth site, taking in everything from audio coding and digital cinema software to medical engineering and non-destructive testing.

Visitors tested the latest devices supported by Cingo® technology, such as special virtual reality goggles. Cingo permits the reproduction of stereo, surround, and 3D sound via smartphone and tablet computer headphones or loudspeakers. In addition, they looked round the foam-pyramid-lined antenna measurement hall, hazarded a panoramic view of the inside of the body via an endoscope, and were introduced to the FitnessSHIRT, which features measurement technology for ECG and recording respiration data.

A highlight in Fürth was the opportunity to see the unique XXL computed tomography system in a hall measuring around 400 square meters of floor space. The system allows X-ray views that penetrate large, solid objects such as cars or even the skull of a Tyrannosaurus rex.

In the Energy Campus Nürnberg, Peter Heusinger from Fraunhofer IIS gave a presentation on the possibility to control various energy consumers in smart homes using a software framework. Saving energy was also a topic at JOSEPHS® in Nürnberg, where Fraunhofer IIS demonstrated that it is possible to create maintenance-free, wireless systems with virtually unlimited operating times and service lives. In addition, many Long Night guests came to the JOSEPHS® service manufactory to try out prototypes and new products and services.



www.iis.fraunhofer.de/Indw2015-en

6 Fraunhofer IIS hosted the opening event of the Long Night of the Sciences 2015. Afterward, the guests of honor seated themselves in a car to experience Symphoria®, the technology for surround and 3D sound in vehicles: (from left) Dr. Ludwig Spaenle, Bavarian Minister of Education, Science and the Arts; Ralf Gabriel, CEO of Kulturidee GmbH; Prof. Albert Heusinger, Director of Fraunhofer IIS; Oliver Hellmuth, head of the Semantic Audio Processing department, who presented the sound system to the guests.



SHARP BRAINS, HOT TIRES

Fraunhofer IIS brings Freescale Cup student world championship to Germany for the first time.

The Freescale Cup, which is sponsored by Freescale Semiconductor, is an international competition for student teams tasked with constructing and programming an intelligent, fully self-driving model car and then racing it against other teams. For the first time in the history of the competition, the decisive final round took place in Germany – at Fraunhofer IIS on September 15, 2015. The winner of the Freescale Cup is the team whose vehicle goes round the previously unknown circuit the fastest without leaving the track. Freescale microcontrollers are used to control the vehicles. All vehicles use the same chassis and the same motors. 25 university teams from eleven European countries and involving a total of 75 students sent their model cars out onto the Fraunhofer IIS grounds to race. The 180 square meter circuit contained bumps, intersections,

hills, and chicanes. The team of students from China had programmed the best mixture of speed and precision into their car and was fastest round the track at the final of the Freescale world championship with a time of 17.1 seconds. Next fastest was the team from Malaysia with a time of 20.6 seconds, followed by the team from Switzerland with a time of 20.8 seconds.



www.iis.fraunhofer.de/freescalecup2015-en

7 The 75 students from 25 universities worldwide worked away on their Freescale cars right up until the last minute.

ART AND TECHNOLOGY: "THE FACE OF FRAUNHOFER IIS"

Individual portraits and digitally merged composites of employees displayed in an exhibition.

To mark its 30th birthday, Fraunhofer IIS invited the social media artist Wolf Nkole Helzle to create a composite portrait of the institute's employees. To do this, the artist carried out photo sessions at several institute locations and made portraits of employees. The resulting pictures were merged through a process of equal superimposition into "The Face of Fraunhofer IIS," a composite face of the institute.

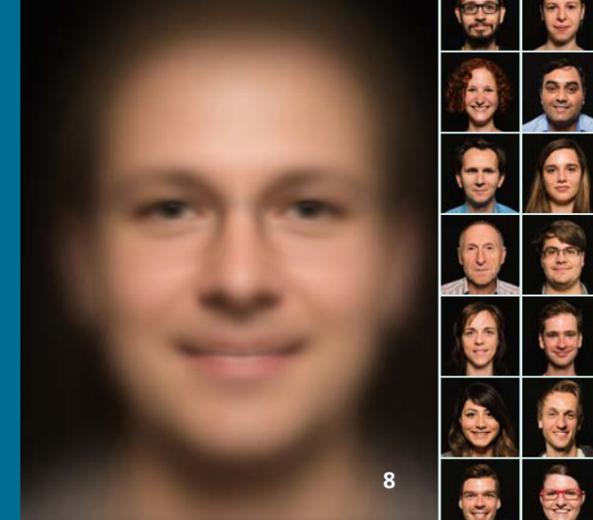
developments, building inaugurations, award ceremonies, and other events. "The Face of Fraunhofer IIS" is a project in the Art and Technology exhibition series, which promotes the interaction between art and technology. The exhibition runs until June 2016 in the public rooms of the institute in Erlangen-Tennenlohe.



www.iis.fraunhofer.de/face-en

The exhibition shows all the individual portrait photos as well as the composite face. Also on display are composite portraits of departments and divisions. Numerous making-of photos document the artistic process and the atmosphere during the art project. In addition, a constantly changing 3D matrix shows 3,000 photos from the 30 years of the institute's history, including pictures of technological

8 "The Face of Fraunhofer IIS" and a selection of the 523 individual portraits of employees.



MRS. T. REX VISITS FÜRTH

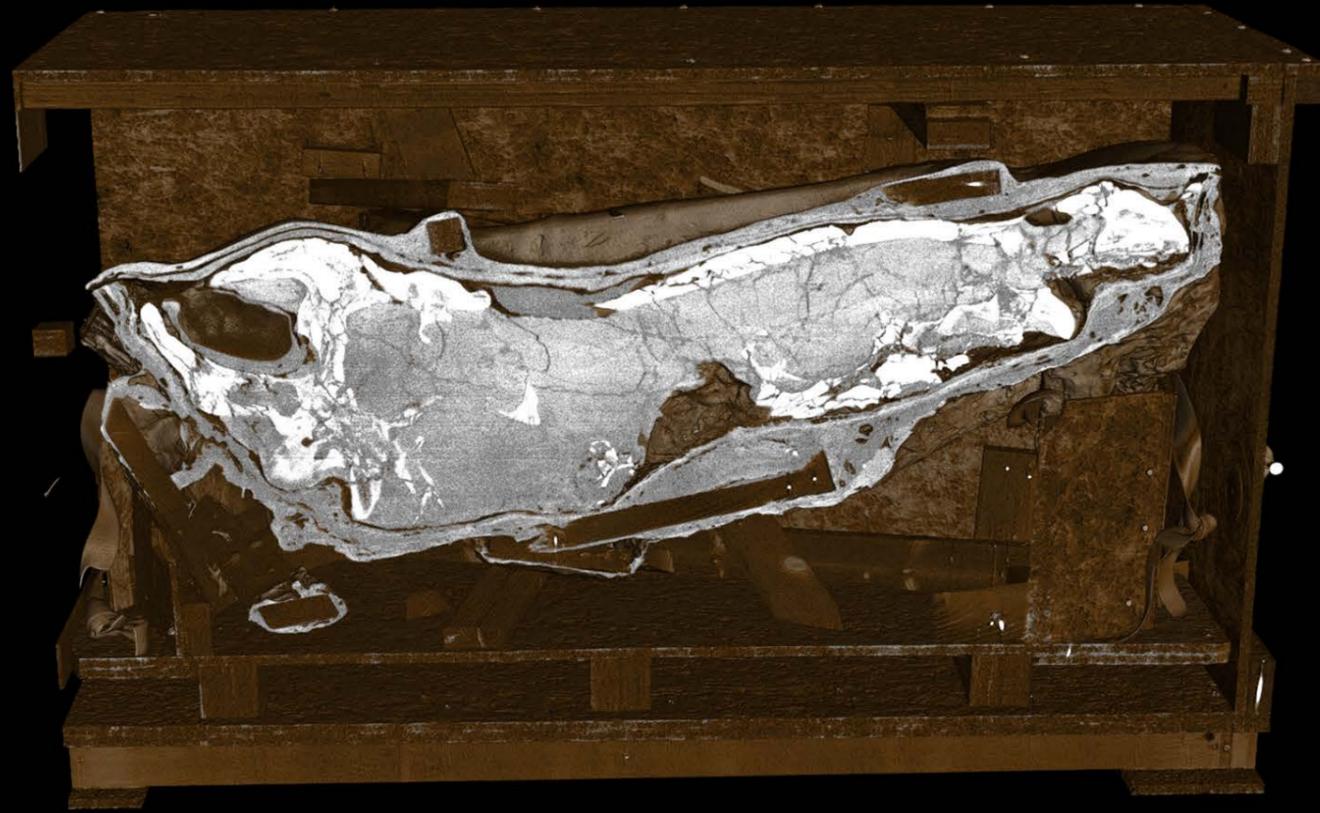
CT scan of T. rex skull presented at press event.

X-raying whole vehicles, large aircraft components, or shipping containers has become almost everyday practice at the Development Center for X-ray Technology (EZRT). These feats are made possible by the XXL CT scanner in the high-energy hall adjacent to the institute building: armed with 20 times the power of a conventional 450 kV X-ray machine, it is able to penetrate even steel plates as thick as a fist, producing pin-sharp images. Inspired by these capabilities, which are unique in the world, the researchers are increasingly being asked to scan artistic and archeological artifacts.

And that is how a female Tyrannosaurus rex eventually wound up at the EZRT, where scientists scanned the skull of the 66.4 million year old specimen. For laypeople, the images produced at the press event on June 19, 2015 are nothing less than impressive. For Dr. Anne Schulp, paleontologist at the Naturalis Biodiversity Center in the Netherlands, the use of XXL CT technology opens up a lot of other possibilities: the precise CT scanning of the skull benefits conservation and preparation work, because it allows museum curators to reliably identify unexpected problems such as concealed fractures in advance and to take this information into account when preparing specimens for exhibition. The X-ray data can also be used to make accurate copies of the skeleton by means of 3D printing techniques. "We're particularly interested in concealed sections of the skeleton. This technology allows us to reconstruct the skeleton in detail – in this case, we can do this especially well, because the skull is in such excellent condition," emphasized Dr. Schulp.



An image to set the pulses of paleontologists racing: the CT scan of an enormous T. rex skull reveals even minuscule details.



For security reasons, the 66.4 million year old skull had to be left in the transport box for the CT scans.



Prof. Dr. Randolph Hanke (center), head of the EZRT division, and his employees Dr. Michael Böhnel (left) and Nils Reims present the X-ray image of the dinosaur head.

FRAUNHOFER IIS IN NUMBERS

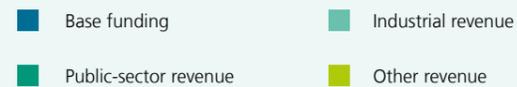
In 2015, the Ifo Business Climate Index was characterized by optimism and reached its highest level in November with 109.0 points. The positive expectations of industrial companies and their willingness to invest were clearly tangible in the last business year. They also contributed to Fraunhofer IIS's good financial results.

Balanced books

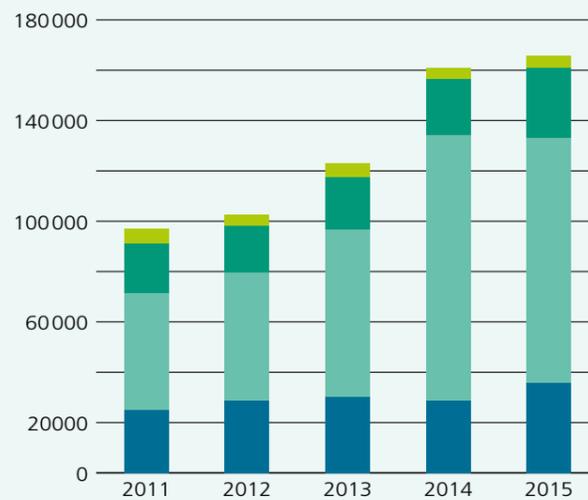
In the financial year 2015, 22% of the institute's income came from base funding from the Fraunhofer-Gesellschaft, while 17% came from public and other revenue and 59% came from industry and business.

A substantial portion of the industrial revenues came from licensing, but R&D services also contributed to the good financial results. After the high one-off license payments in 2014, income slowly returned to normal levels in 2015.

A rise in revenue from public sources of €6 million was achieved through the approval of new research, development, and funding projects. Based on current orders, Fraunhofer IIS expects balanced annual results once again in the 2016 financial year.



166
million euros in funding



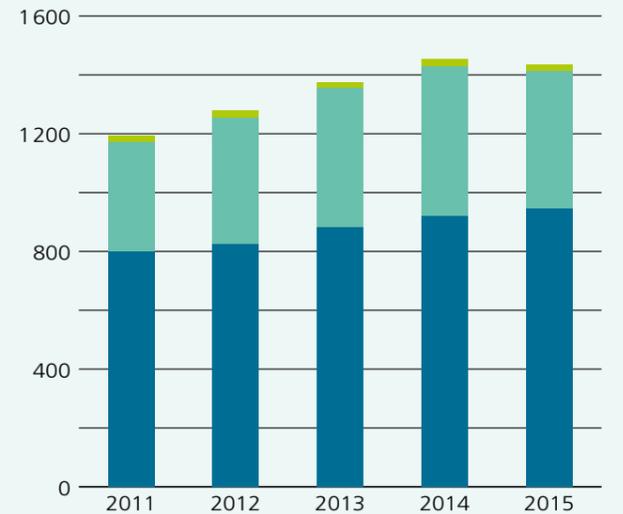
Increasing number of jobs covered by collective wage agreements for public service employees (TVöD)

Moderate growth is necessary to maintain a leading position in the research landscape, as the past few years have demonstrated. As a result of the healthy economic situation in Germany, Fraunhofer IIS is competing with many companies for highly qualified job applicants.

In spite of this, Fraunhofer IIS has grown in its various locations over the past financial year – the number of employees covered by collective wage agreements for public service employees (TVöD) has gone up.



947
TVöD employees

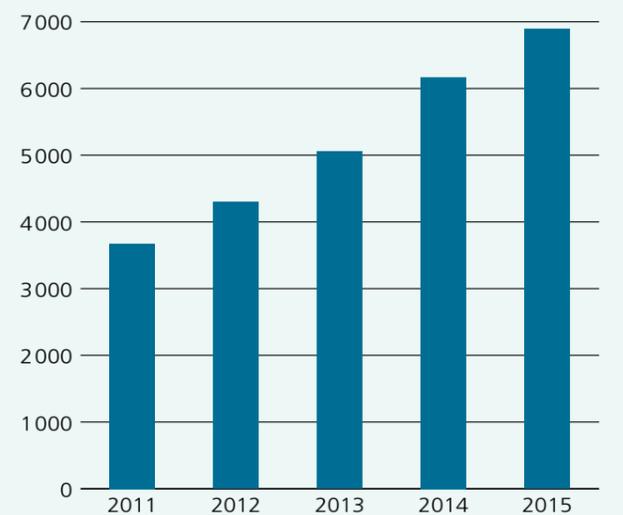


Patent portfolio growing

With a portfolio of 6,886 patents, Fraunhofer IIS is well positioned again for 2016. Compared to the year before, there were 671 more patents in 2015, which continues the upward trend of previous years.

The diagram shows the number of active patents (patent portfolio) for different years. Both the number of new patents and the constantly growing patent portfolio testify to Fraunhofer IIS's innovation prowess.

6886
patents in portfolio





FRAUNHOFER IIS AS A PARTNER

Outstanding ideas. Application-oriented research. Cooperation you can rely on.

Fraunhofer IIS helps companies to develop and implement technologically ambitious and competitive solutions. In keeping with your wishes and specifications, we design studies and develop solutions, build everything from prototypes to complete systems, or support your company with our scientific expertise. We accompany you from the initial idea all the way through to the market-ready product – always tailoring our services to your specific needs.

We offer the following forms of collaboration:

- Research and development
- Licensing of technologies and systems
- Consulting and project support
- Market studies



CONTACT

Dr. Christian Forster
Group Manager Business Development and Innovation

Phone +49 9131 776-1066
christian.forster@iis.fraunhofer.de



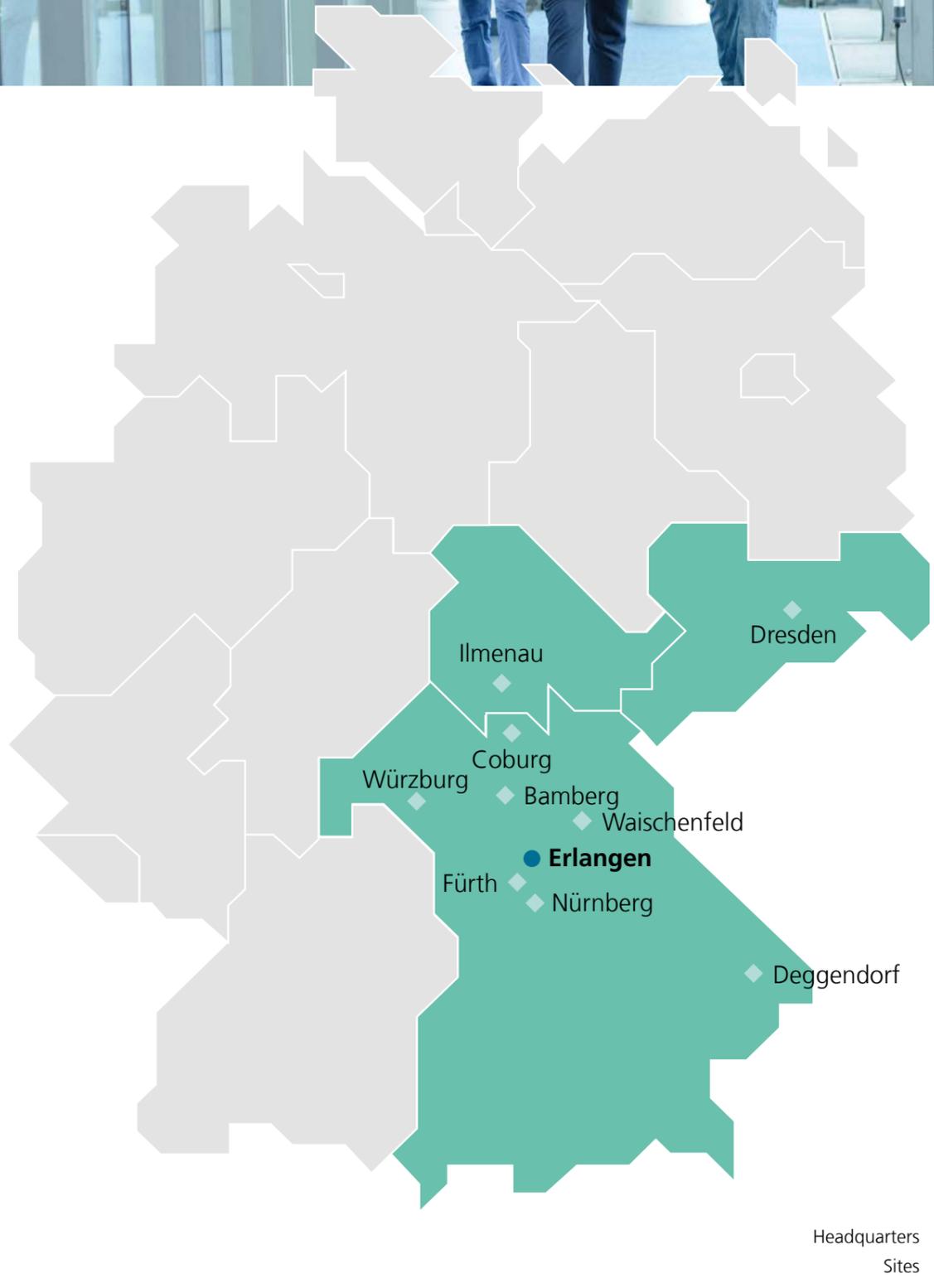
FRAUNHOFER IIS IN PROFILE

The Fraunhofer Institute for Integrated Circuits IIS is one of the world's leading application-oriented research institutions for microelectronic and IT system solutions and services. It ranks first among all Fraunhofer Institutes in size. With the creation of mp3 and the co-development of AAC, Fraunhofer IIS has reached worldwide recognition.

In close cooperation with partners and clients the Institute provides research and development services in the following areas:

- Audio & Multimedia
- Imaging Systems
- Energy Management
- IC Design and Design Automation
- Communication Systems
- Positioning
- Medical Technology
- Sensor Systems
- Safety and Security Technology
- Supply Chain Management
- Non-destructive Testing

About 950 employees conduct contract research for industry, the service sector and public authorities. Founded in 1985 in Erlangen, Fraunhofer IIS has now 13 locations in 10 cities: in Erlangen (headquarters), Nürnberg, Fürth, Dresden, further in Bamberg, Waischenfeld, Coburg, Würzburg, Ilmenau and Deggendorf. The budget of 130 million euros is mainly financed by projects. 22 percent of the budget is subsidized by federal and state funds.



The organizational units for the individual sites are shown in the organizational chart on the following pages.

FRAUNHOFER-GESELLSCHAFT WORLDWIDE



Fraunhofer operates subsidiaries in Europe and in North and South America. Representative offices and senior advisors worldwide act as a bridge to local markets. An office in Brussels works as an interface between Fraunhofer and EU institutions. Numerous strategic collaborations with excellent international partners round off the portfolio.

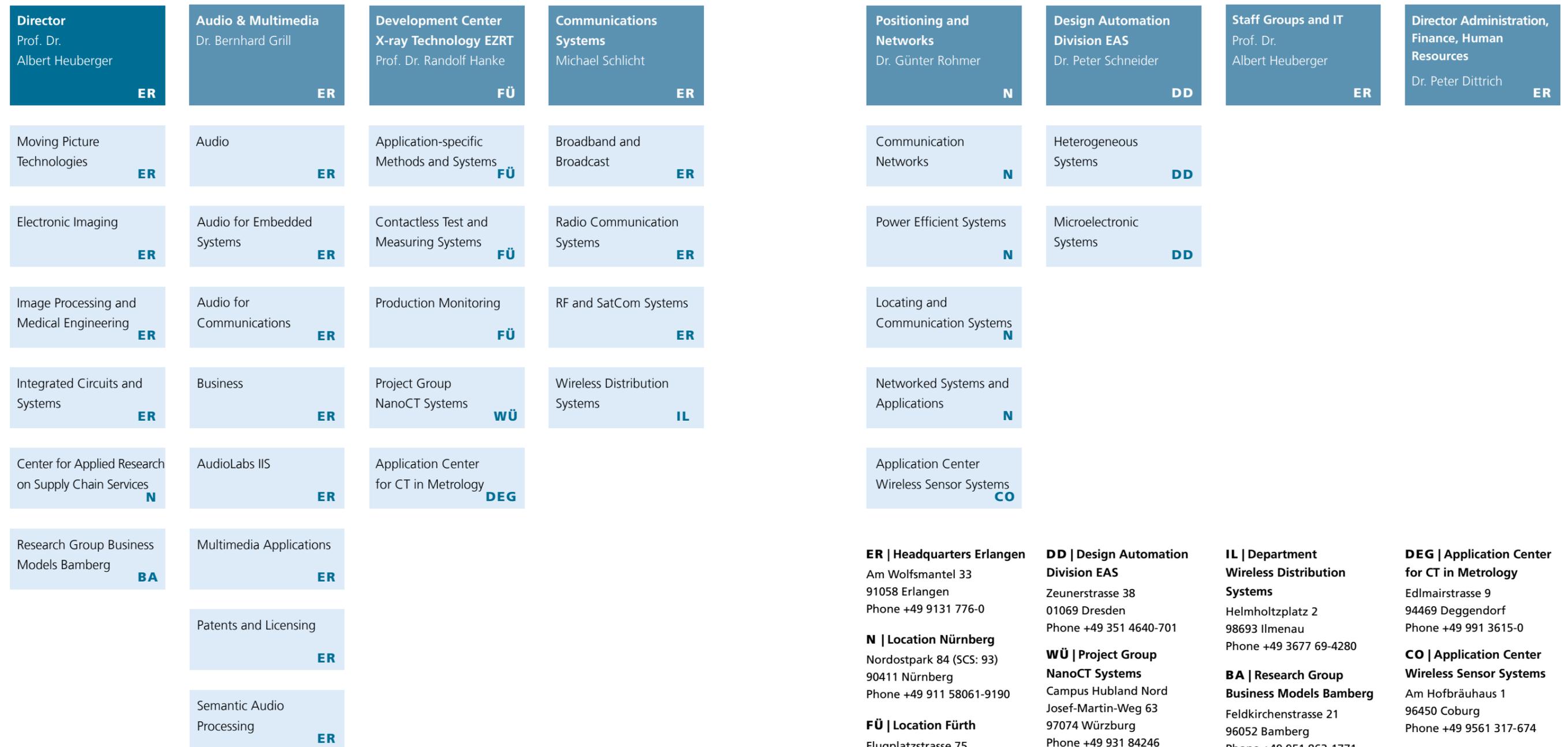


[www.fraunhofer.de/
international-en](http://www.fraunhofer.de/international-en)



ORGANIZATION CHART

Director: Prof. Dr. Albert Heuberger
Deputy Director: Dr. Bernhard Grill, Prof. Dr. Randolph Hanke
Director Administration: Dr. Peter Dittrich



ER | Headquarters Erlangen
 Am Wolfsmantel 33
 91058 Erlangen
 Phone +49 9131 776-0

N | Location Nürnberg
 Nordostpark 84 (SCS: 93)
 90411 Nürnberg
 Phone +49 911 58061-9190

FÜ | Location Fürth
 Flugplatzstrasse 75
 90768 Fürth
 Phone +49 911 58061-7500

DD | Design Automation Division EAS
 Zeunerstrasse 38
 01069 Dresden
 Phone +49 351 4640-701

WÜ | Project Group NanoCT Systems
 Campus Hubland Nord
 Josef-Martin-Weg 63
 97074 Würzburg
 Phone +49 931 84246

IL | Department Wireless Distribution Systems
 Helmholtzplatz 2
 98693 Ilmenau
 Phone +49 3677 69-4280

BA | Research Group Business Models Bamberg
 Feldkirchenstrasse 21
 96052 Bamberg
 Phone +49 951 863-1771

DEG | Application Center for CT in Metrology
 Edlmaistrasse 9
 94469 Deggendorf
 Phone +49 991 3615-0

CO | Application Center Wireless Sensor Systems
 Am Hofbräuhaus 1
 96450 Coburg
 Phone +49 9561 317-674

MEMBERS OF THE ADVISORY BOARD

The Advisory Board advises the institute's directors and helps to forge contacts with industry and other organizations.

Dr. Annerose Beck, Saxon State Ministry for Science and the Arts, head of "Federal/State Research Institutions" department

Jürgen Beuthner, TechniSat Digital GmbH, former managing director

Dr. Bernd Ebersold, Thuringian Ministry for Education, Science and Culture, head of "Research and Scientific Infrastructure" department

Prof. Karl-Dieter Gröske, Friedrich-Alexander University of Erlangen-Nürnberg, former president

Dr. Gerd Gruppe, German Aerospace Center (DLR), member of the Executive Board

Klaus Helmrich, Siemens AG, member of the Managing Board

Prof. Franz Kraus, ARRI AG, Managing Director and member of the Executive Board

Dr. Ulf Lange, Federal Ministry of Education and Research, head of "Communication Systems; IT Security" department

Dr. Ronald Mertz, Bavarian Ministry of Economic Affairs and Media, Energy and Technology, head of "Innovation, Research, Technology" department

Dr. Dietmar Schill (Chairman of Advisory Board), Sony Deutschland GmbH, Divisional Director

Dr. Marc Steckling, Airbus Group, head of "Lean Management" department

Dr. Alexander Tettenborn, Federal Ministry for Economic Affairs and Energy, "head of Development of Digital Technologies" division

Dr. Keith Ulrich, Athenga GmbH, CEO

Norbert Michael Weber, Federal Ministry of Defence, head of "Basic Research, Research Institutes, International Research and Technology Cooperation" department

Jürgen Weyer, VP Automotive Sales EMEA, NXP Semiconductors, General Director

Reiner Würz, Continental Automotive GmbH, R&D Advanced Development Manager

AWARDS AND PRIZES

Joseph von Fraunhofer Prize

Oliver Hellmuth, Jan Plogsties, Harald Popp for the development and market launch of Cingo® and Symphoria®

Eduard Rhein Foundation Technology Award

Prof. Karlheinz Brandenburg, Dr. Bernhard Grill, Prof. Jürgen Herre

EARTO Innovation Award

2nd place in "Impact Delivered" category

Upper Franconia Foundation Special Prize

Prof. Heinz Gerhäuser for his many years of scientific engagement and his dedication to the structural development of the Upper Franconia region

Female Recruiting Award 2015

2nd place, HR Marketing Fraunhofer IIS, "women & work" trade fair

MBDA 1-Star Award: MBDA Innovation Award 2014 on theme of "Anti-Jamming GPS System"

Alexander Popugaev, Markus Landmann, Gregor Siegert, Christopher Schirmer, Alexander Rügamer, Ivana Lukcin, Shrikul Joshi

Deggendorf Academic Award 2015

Fraunhofer Application Center for CT in Metrology

Werth Foundation Award 2015

Mario Salzinger, Bachelor thesis: "Investigation of filter characteristics when measuring using industrial computed tomography compared to tactile measuring systems"

German Design Award 2015

bit express digital campus radio, Uwe Eger (external employee), "Graphic Fine Arts / Excellent Communications Design" category

High-Efficiency Power Amplifier Student Design Contest

Michael Kamper, 1st place, IEEE Microwave Theory and Techniques Society (MTT-S) International Microwave Symposium

EDITORIAL NOTES

Published by

Fraunhofer Institute for Integrated Circuits IIS
Prof. Albert Heuberger

Am Wolfsmantel 33
91058 Erlangen, Germany
Phone + 49 9131 776-0
Fax +49 9131 776-1649
info@iis.fraunhofer.de
www.iis.fraunhofer.de

Editorial team

Thoralf Dietz, Angela Raguse-Föbel, Thomas Kondziolka,
Patricia Petsch, Matthias Rose, Verena Rösel, Janine van
Ackeren (external), Ilona Hörath (external)

Layout and production

Kerstin Krinke, Paul Pulkert

Proofreading

Thoralf Dietz, Dr. Karlheinz Kirsch, Patricia Petsch

Printed by

Nova Druck Goppert GmbH

Contact

Fraunhofer Institute for Integrated Circuits IIS
Corporate Communication
Am Wolfsmantel 33
91058 Erlangen, Germany
Phone + 49 9131 776-1631
Fax + 49 9131 776-1649
presse@iis.fraunhofer.de

Photo acknowledgements

Cover picture: Oliver Sved - fotolia.com/Fraunhofer IIS
Page 6, 8, 11, 14, 16, 17, 22, 25, 34, 43 right, 44:
Fraunhofer IIS/David Hartfiel
Page 14, 16, 17: collaboration with Schloss Thurn
Page 2, 4, 5, 51, 64, 66, 69: Fraunhofer IIS/Karoline Glasow
Contact pictures page 13, 19, 27, 39, 49, 65:
Fraunhofer IIS/Karoline Glasow
Page 13: Fraunhofer IIS/Fabian Leander Sinzinger
Page 19: Dirk Mahler/Fraunhofer
Page 20: Fraunhofer IIS/Matthias Heyde
Page 21 left: Carl Hanser Verlag
Page 21 right, 28, 36, 37, 38, 39, 41 left, 41 right,
53 right, 55 right, 56: Fraunhofer IIS/Kurt Fuchs
Page 29 left: Fraunhofer IIS/Bianca Möller
Page 29 right: Fraunhofer IIS/Johann Hauer
Page 31 left: Fraunhofer IIS/Sandra Kundel
Page 31 right: Toni Kretschmer
Page 32: iStock.com/jarino47
Page 33: Fraunhofer IIS/Rida El Ali
Page 40: Fraunhofer IIS/alphaspirit – Fotolia.com
Page 42: Fraunhofer IIS/Leon Greiner
Page 46, 47: Erhardt + Abt Automatisierungstechnik GmbH
Page 49: Fraunhofer IIS/Gerhard Hagen
Page 54, 57 left, 61: Fraunhofer IIS/Peter Roggenthin
Page 55 left: Adrian Bedoy
Page 57 right: Fraunhofer IIS/Wolfgang Nkole Helzle
Page 59, 60: Naturalis Biodiversity Center/Fraunhofer IIS
Page 71: Fraunhofer
All other images: © Fraunhofer IIS

All rights reserved. Reproduction of any material requires
the editors' consent.

Report period

January 1 to December 31, 2015

© Fraunhofer IIS
Erlangen, February 2016

