



**Fraunhofer**

**IIS**

FRAUNHOFER INSTITUTE FOR INTEGRATED CIRCUITS IIS

**ANNUAL REPORT**

**2012**



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## Contents

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<b>Preface</b>	<b>07</b>
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<b>Highlights</b>	<b>09</b>
<i>The Digital Radio Sound Experience</i>	10
<i>Farther Than the Eye Can See</i>	16
<i>GoalRef</i>	22
<i>Creating Transparency</i>	28
<i>20 Years of the EAS Division in Dresden</i>	34

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<b>Facts</b>	<b>41</b>
<i>The Institute in Profile</i>	42
<i>Fraunhofer IIS – A Partner for Industry</i>	44
<i>Advisory Board</i>	46
<i>Contacts</i>	47

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<b>The Institute in Figures</b>	<b>51</b>
---------------------------------	-----------

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Editorial Notes	54
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**"INVENTIONS THAT CHANGE THE WORLD  
ARE RARELY THE RESULT OF IVORY-TOWER  
RESEARCH"**

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*Guglielmo Marconi*

*(Italian entrepreneur and wireless pioneer, 1874–1937)*



# PREFACE

Dear readers,

When I took over the role of Executive Director of this institute on October 1, 2011, my initial objective was to assure continuity during the transitional phase. I began my term of office by taking a thorough look at the way the various departments and the Institute as a whole were organized in terms of research areas and business strategies.

The results of the Fraunhofer-wide employee survey carried out in late 2011 revealed that the level of satisfaction within the organization is relatively high. Nonetheless our employees, who constitute our most important asset, pointed out various areas where we need to improve our internal processes.

In consultation with our management team, I launched various initiatives to develop the scope of the Institute's research activities and business strategy, and formulated corresponding targets. We set up strategy processes in all departments to serve as a basis for their future development. Operating as one institute, but spread over several locations, we aim to achieve moderate, sustainable growth within the context of the Fraunhofer model.

We all share the objective of working together to continue the Institute's successful work. Our aim is not only to do the right things, but also to do things right.

One small thing that has changed, in a way we hope you appreciate, is before your eyes at this very moment: our redesigned Annual Report. Instead of devoting the same column space to each of our departments, as we have done every year so far, we have selected five topics to be highlighted in greater detail, in a more journalistic style. To meet financial reporting requirements, a presentation of facts and figures is provided in a separate section.

I hope you enjoy reading the content of this report and look forward to hearing your comments.

Prof. Dr. Albert Heuberger  
Executive Director of the Fraunhofer Institute for Integrated Circuits IIS

A handwritten signature in black ink, appearing to read 'Albert Heuberger', with a stylized flourish at the end.









*Highlights*

## **THE DIGITAL RADIO SOUND EXPERIENCE**

Tuning in to analogue radio is nothing new. Almost every household is able to receive FM broadcasts, and we generally don't ask much of the equipment we use to listen to them. But you can get a lot more out of radio when the technology is digital: better sound, more information, and convenient operation. More and more listeners discovered these advantages for themselves in 2012, and in the same year digital radio enjoyed a successful new start in Germany, not least thanks to the work of the Fraunhofer IIS.



# DIGITAL MAKES IT POSSIBLE

How many radios do you have? How many times a day do you listen to the radio? And where can you catch up on live coverage of the latest news without any extra effort? As the fastest and most flexible medium, radio is a natural choice. We listen to it whenever we like, wherever we happen to be. The new digital standard DAB+ (Digital Audio Broadcasting) further extends our possibilities. Those who have ever used the station selector on a digital-radio display will never want to have to search for stations by frequency again. And those who have listened to their favorite opera from start to finish on a drive across Germany would rather switch off when the FM signal turns noisy. Digital radio is booming, and no one honestly could be happier about that than Olaf Korte, the computer scientist managing the digital-radio project at the Fraunhofer IIS. He and his team are developing applications for radio systems. »Now everybody can benefit from the work we've done over the last twenty years« he says.

The radio should not be seen merely as the thing we switch on to listen to the weather bulletin in the morning in the bathroom, or to a symphony in the car. Looking behind this often inconspicuous piece of electronic equipment we discover the technology that enables signals to be received and decoded as programs and services, over a suitable broadcasting infrastructure. The Fraunhofer IIS has played an active role in driving forward developments in all related fields of technology, enabling more intelligent broadcasting of audible sound, more efficient reception, interactive listening and even multimedia enhancement - a whole host of possibilities. But what does this technology offer, and how does it actually work?

## **How does radio benefit from additional services?**

Additional services are what make digital radio so special. One example is Journaline. This bespoke service, developed with significant input from the Fraunhofer IIS, works in a similar way to teletext. Journaline provides continuously updated program information, such as news, sports results, stock market prices, cultural events, weather reports and much more besides. Users can read these bulletins on the radio display itself, or have them read out, which is especially useful in the car. It's also possible to call up information of specific services and get answers to questions like »When exactly will my mother's train arrive at the station« or »What was that phone-in number again?«

Journaline is extremely simple. Users navigate intuitively

through the information received and pinpoint the news they are after. They can bookmark and save their special-interest topics as favorites, allowing direct access at any time to the local weather forecast, sports results or other local reports and information, for example.

»Radio operators have recognized the possibilities of Journaline's hybrid approach i.e. the combination of radio with other means of communication. The Hot Button on a suitably equipped radio allows the user to phone a given mail-order or studio hotline as it appears, or to take part in an on-air vote or competition via SMS. Digital radio can in this way help to make the bond between the listener and his favorite station even stronger and more stimulating,« says Alexander Zink, project manager for Journaline at the Fraunhofer IIS.

Journaline is in operation in Germany and throughout the world. Broadcasters include DeutschlandRadio via DAB+, the BBC, Voice of Russia and Radio Vaticana using DRM via shortwave, and Total Traffic Plus in the USA. Dr Chris Weck, Head of Radio and Information Technology at DeutschlandRadio, is a keen proponent of the service. »As a supplementary service for digital radio, Journaline provides DeutschlandRadio with the ideal platform to supply its listeners, including those on the move, with its full range of news and information. Being able to offer this free text service without an Internet connection is an important and really useful addition to our digital-radio programming in today's multimedia world, not least because you can use it any time you want,« he says.

### What is better about digital traffic services?

You can't be without traffic reports in the car, and the technology has been upgraded here too. The digital successor to the analogue traffic service is TPEG (Transport Protocol Experts Group). TPEG goes above and beyond its analogue predecessor TMC. The driver receives traffic-jam and parking-status updates, information about speed restrictions, fuel prices, weather conditions and even details of other means of transport, such as buses and trains. Thomas Kusche, Managing Editor of the television and radio broadcaster WDR in Germany and President of the Traveller Information Services Association (TISA), sees this as a major plus point. »Digital radio opens up new avenues for traffic information services, which will allow us to paint a comprehensive picture of safety-relevant events. That will spur on many business models and the success of digital radio,« he says. To allow manufacturers to integrate TPEG into radios as easily as possible, Fraunhofer IIS has developed TPEG decoder software. Implementing this saves manufacturers time and money.

### Is the technology already on the market?

Digital quality is available for everything from the radio in the kitchen to the receiver in your car and components for the hi-fi. DAB+ radios are recognizable by the »digital radio« logo on packaging.

The smallest digital radio is no larger than a USB stick, and is equipped with Fraunhofer's MultimediaPlayer software. The NOXON DAB Stick simply connects to a computer, and has a recording scheduler among other capabilities. Additionally, the software displays a list of stations and data services such as Slideshow and Journaline. If the computer is fitted with a multi-channel soundcard DAB Surround-Audio Programs can even be rendered in 5.1 Surround.

The stick is just one example of the many components with which Fraunhofer supports chip and radio manufacturers. To this end, all types of applications are considered, from battery-operated portable mini receivers right up to premium

car radios. DAB+ radios can, of course, also receive DAB and FM broadcasts.

### Why does digital radio sound so good?

No signal noise, and no crackling. The digital-radio experience is crystal clear. Digital transmission presents many opportunities to improve sound. Disturbances and transmission breaks are counteracted with sophisticated error correction, for example. The result is a clear audio signal even under difficult reception conditions.

### Can digital radio sound even better?

If you are used to enjoying your DVDs and Blu-Rays with 5.1 Surround Sound, you won't want to compromise when it comes to listening to the radio. And you don't have to: DAB Surround developed by Fraunhofer combines the HE-AACv2 codec used in DAB+ with MPEG surround. This produces digital radio in 5.1 Surround Sound by sending a small supplementary data package, leading to lower bitrates and the best audio quality. »The conversion using MPEG Surround is extremely simple. The process works so efficiently that the surround sound can be sent over the same channel along with the stereo program,« Olaf Korte says, expanding on the benefits of the technology. According to Korte, this is an important factor, as the broadcaster incurs no additional transmission costs. DAB+ test broadcasts with 5.1 surround sound are currently in progress in Germany (see the »Short Facts« box).

### What's the station search all about?

You may discover on long car journeys that you are not able to hear your favorite opera on FM through to the end, because you have left the reception area. The search system RDS does not always help, and even then, the desired station is not available everywhere. Digital radio allows nationwide programs to be received from Salzburg to Flensburg on one frequency. Re-tuning on the move is a thing of the past, and everybody can enjoy their favorite opera to the very last note.



### **Which programs are offered on digital radio?**

Thanks to digital data compression, more programs can be broadcast over the available frequencies. This creates free space for new stations and new listening experiences. Football radio stations with nationwide coverage simultaneously transmit live reports of several Bundesliga games at once. The listener can choose which game he wants to root for, and opt to receive text information and game updates. Alongside football radio stations a whole range of other programs can be received, including the science program DRadio Wissen, music from Digital Classic, Radio Energy, Absolut Radio, Radio Bob and Rockantenne, as well as religious stations such as ERF and Radio Horeb.

### **Can digital radio be found anywhere else?**

Listeners in Switzerland, Great Britain and Norway have embraced digital radio most keenly. Jørn Jensen, President of WorldDMB (World Digital Multimedia Broadcasting), reveals more: »DAB or DAB+ is accepted as the digital broadcasting standard for radio stations throughout Europe and in large areas of the Asia-Pacific regions. It's a brilliant success, further strengthened by the fact that most leading car manufacturers are implementing the standard. In the future, DAB+ digital radio will be available on all radios, giving the listener multimedia extras and reducing transmission costs dramatically for radio stations,« he says.

### **How is the Fraunhofer IIS supporting the radio industry?**

Fraunhofer technologies underpin not only the basic digital radio standard, from audio compression to data services and signal rendering, but also form an integral part of many products that enabled the successful introduction of digital radio to Germany in the first place. Manufacturers use these technologies to introduce their own products quickly and successfully onto the market. Many of the radio encoders

used by broadcasters and made by different manufacturers are based on Fraunhofer's ContentServer Technology. These highly compact solutions combine real-time audio encoding with the complete management of all standardized data services, and the production of the final digital broadcast signal.

On the receiving end, Fraunhofer technologies offer radio manufacturers a wide range of options. These extend from chipset implementation for DAB+ reception, to decoder components for audio and data services like Journaline and TPEG, through to complete PC-based radio solutions.

### **What's next for digital radio?**

Thanks to all these new quality standards, digital radio now has a real place in the media age – and it's basically more fun. The broadcast network now covers major conurbations and the most important transport routes, and reaches around 40 million people. It is set to expand incrementally, until coverage across the whole country is achieved. The network should expand to 110 sites by 2015. In more and more areas of Germany, such as Munich, over 40 programs are already available.

When it comes to the German market, car manufacturers are also focusing intensely on the new generation of digital radio. The most important brands already offer receivers with DAB+. The first cars with these digital radios fitted as standard are on the market.

Over twenty years' experience with the DAB standard and its underlying technologies, coupled with a wide-ranging set of solutions both for broadcasting and receiving, single out the Fraunhofer IIS now and in the future as a digital-radio expert. »We belong to the few who were there from the very start, and we have devoted creativity and competence non-stop for twenty years. We will continue to support our partners in the long term,« says Olaf Korte.



### **Statement from Johannes Trotzberger, Bayern Digital Radio GmbH**

»Varied programming is at the heart of digital radio. New shows, including those for niche audiences, are now possible. On that note, what's still missing at the moment is a radio for children, especially considering the increasing number of children from migrant backgrounds in Germany.

The radio market has developed enormously compared to last year. There are numerous devices offering value for money, and awareness of digital radio has also increased measurably, not least thanks to promotional campaigns led by public service broadcasters. The introduction of the National Digital Radio Multiplex was another major step.

New services are an important factor. Telematics applications are one example, but so are feedback-channel services that can map listening habits through voting, for example. In the next one to two years, such services will become increasingly more significant.

Meanwhile, The European Broadcasting Union (EBU) has also made the digital-radio theme a focus. A compulsory switch-off date for analogue radio, as has already been announced in Great Britain and Norway, for example, is paramount for the successful widespread introduction of digital radio. And taking things one step farther, a marketing structure targeting the needs of digital radio must be developed.

The strategic partnership between Bayern Digital Radio and Fraunhofer IIS was and is essential, most notably in the introduction of the new pioneering Digitalradio-Multiplexer-Systems, and in the practical implementation of data services. It is the story of successful symbiosis between development and application, in which each party contributes its respective expertise and experience to the maximum. I can therefore confidently say that this partnership will continue fruitfully in the coming years.«

### **SHORT FACTS / CONTACT**

*DAB+: Latest digital radio standard from WorldDMB.*

*Facilitates e.g. nationwide reception of radio stations*

*HE-AACv2: Globally deployed audio codec for broadcast and streaming. Used in DAB+ to deliver high audio quality at very low bit-rates. Co-developed by Fraunhofer IIS.*

*bit eXpress: Digital test station run by the Friedrich-Alexander-Universität Erlangen-Nürnberg and the Fraunhofer IIS.*  
[www.bitexpress.de](http://www.bitexpress.de)

*Traveller Information Services Association (TISA): Globally active organization advocating the expansion of services and products for traffic and travel information.* [www.tisa.org](http://www.tisa.org)

*WorldDMB: (World Digital Multimedia Broadcasting): International organization setting standards for digital radio*  
[www.worlddab.org](http://www.worlddab.org)

*Current information about programs, broadcast areas, radios and car radios:* [www.digitalradio.de](http://www.digitalradio.de)

*Test broadcasts using DAB Surround:* <http://lmc.af.ee/ezn27>

*Journaline is the standardized advanced text application for digital radio with optional backchannel-interactivity for a hybrid radio experience:* [www.journaline.info](http://www.journaline.info)

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*Highlights*

## **FARTHER THAN THE EYE CAN SEE**

Human perception is limited by the capacity of our senses, which only provide us with an incomplete and sometimes inaccurate picture of the world. The imaging techniques developed by Fraunhofer IIS allow us to see the reality that exists beyond the reach of our senses. They can make polarized light visible, deliver measurement data derived from images, and interpret facial expressions. Fraunhofer IIS received awards for two such development projects in 2012: the POLKA polarization camera won the Georg Waeber Innovation Award and GfK EMO Scan won the German Innovation in Market Research Award.

# A NEW VISION OF THINGS

Vision is about more than just optical physics. Every light stimulus that triggers a sensory response in the eye is recorded in a specific area of the brain, compared with previously memorized experiences, and interpreted accordingly. Similarly, while modern cameras still record light information, they now also process that information digitally with the aid of software. The resulting images enable people to see polarized light, for example, or determine the speed of a moving object. Sometimes the software is more important than the camera hardware. By comparing the recorded images with reference images stored in a database, it is possible to obtain an objective analysis. POLKA, INCA and GfK EMO Scan are just some of the names of Fraunhofer systems or co-developed products that provide us with a new vision of reality and can be used in a surprisingly wide range of applications. Their visual acuity is superior to that of the human eye in many respects.

Imaging techniques reveal things that are normally invisible or difficult to interpret at first glance. A camera records images of an object, and a software program processes and edits the digital data. The resulting synthesized images are easier to understand and provide additional information.

## **Bees see patterns in the sky that are invisible to us**

Humans are unable to perceive the polarization direction of light without the assistance of special instruments, whereas bees and other insects, and the Fraunhofer POLKA camera, are capable of recognizing the patterns in this colorful phenomenon, which are invisible to the human eye.

If you consider light as a wave, polarized light consists of light waves oscillating in a single plane. The sun radiates unpolarized light that vibrates in all directions. As sunlight passes through the atmosphere, it is diffused by particles suspended in the air. This causes the planes of oscillation and the amplitude of the light waves to change. The light that reaches Earth is partially polarized in different ways depending on the position of the sun. Bees have eyes that can detect this polarization. For them, a clear sky is not evenly blue but full of patterns. This polarization sensitivity enables them to calculate the position of the sun and use this information for navigation, even when clouds obscure part of the sky.

## **Taking machine vision to a new dimension**

The polarization camera developed at Fraunhofer IIS enables human beings to see the planes of oscillation in polarized light. By detecting and analyzing the polarization characteristics of a given surface, it is possible to obtain information on its composition and detect signs of inherent material stress.

In industrial environments, the polarization of light contains valuable, albeit as-yet little-used information. For instance, stress-induced birefringence in glass or transparent plastic is accompanied by changes in polarization. The ability to detect such alterations can greatly aid production monitoring, design optimization and final product inspection.

With its compact dimensions and low weight, POLKA is the first polarization camera to offer such advanced technology in a small, simple package.

## **POLKA captures everything in a single image**

Conventional polarization cameras are complex devices that require rotating polarizing filters, beam splitters and LCD shutters to be mounted in front of the sensor. And in most cases the images produced by the polarization cameras in use today are made up of multiple frames. The time delay involved blurs the image – experts refer to motion artefacts. POLKA, however, is capable of delivering information on the intensity, angle and degree of polarization in a single image. Moreover, it is faster

than the majority of conventional cameras, which makes it eminently suitable for testing moving parts.

### **Wide and varied applications potential**

POLKA has great potential to widen the scope of non-destructive testing, and will facilitate the development of completely new methods of testing and analysis. One promising field is quality control in lightweight construction. By analyzing the polarization information provided by POLKA, it will be possible for the first time to monitor the alignment of individual fibers as they are laid down in woven carbon fiber sheets during the production process. The ability to control this essential quality factor will give the manufacturer a decisive competitive advantage. There are many more examples of potential applications, in fields as varied as optical measurement, medical devices, and safety engineering.

The IIS team, made up of Jürgen Ernst, Dr. Stephan Junger and Wladimir Tschekalinskij, won the Georg Waeber Innovation Award 2012, awarded by Förderkreis für die Mikroelektronik e. V., for the development of this special camera with wide applications potential.

### **A camera that records more than just images**

Just a few more meters to go before the finishing line. The mountain biker leaps across the last hump and makes a hard turn into the final straight, with the rest of the pack hot on his tail. In moments like this, it's frustrating to be a simple spectator. It would be so much more exciting if you could experience the same sensations as the man in the saddle. What's going on in his mind as he accelerates down the straight? Is his pulse rate rising, and what is his emotional state? Sports spectators might soon be able to obtain such real-time information from the INCA intelligent camera, which records more than just images.

INCA is a digital camera system equipped with a diversity of sensors that provide data on GPS position, acceleration, temperature, and air pressure. The miniature camera can be connected wirelessly to other devices, such as a harness to

track heart rate, through Bluetooth or WLAN. It can even be equipped with facial recognition and analysis functions because INCA's powerful integrated processor is capable of handling complex algorithms directly onboard the camera. In this way, sports enthusiasts might one day be able to take a tiny peek into the feelings experienced by competitive athletes. INCA can also work with object recognition and voice detection systems.

### **INCA takes to the skies**

The INCA camera is powerful enough to handle professional film and TV productions. In 2012, Terra Mater Factual Studios, a subsidiary of the RED BULL Media House, asked Fraunhofer IIS to develop a camera capable of producing animal documentaries from an entirely new perspective, namely viewed through the eyes of the animals themselves. The idea was to produce a narrative film for cinema relating the tale of the unusual friendship between Abel, an eagle chick who had fallen from his nest, and Felix, a careworn shepherd living in the isolation of the Alps.

A prototype of the INCA camera was already in existence at the time. But it had to be modified to ensure the camera doesn't interfere with the bird's natural flight. This meant it had to be light, perfectly adapted to the bird's anatomy, and extremely robust. At the same time, the camera's designers were not allowed to make any concessions on image quality, given that the aim was to produce a full-length feature film with top-quality photography.

Meeting these requirements was a huge challenge for the scientists. As Fraunhofer IIS group manager Wolfgang Thieme relates: "It was difficult enough to pack all of the different camera functions into the INCA's compact format. The breakthrough that made this possible was the OMAP (Open Multimedia Applications Platform) processor. As the heart of the camera, this is comparable to a CPU that you find in any ordinary PC. The difference is that additional function blocks for various tasks have been integrated into the OMAP. Without these blocks, the system would neither record HD video images nor process and issue them in real time. The most difficult task



was programming these blocks in such a way that their output could be used by the data processing system.”

Thanks to the help of Fritz Sammer, the production company's technical advisor, and falconer Paul Klima, it took the Fraunhofer researchers no more than nine months to develop a camera platform perfectly adapted to the eagle's anatomy. It weighs just 80 grams and yet contains all of the sophisticated technical functions of the original INCA design. In total, the wildlife film "The Way of the Eagle" will have taken four years to produce by the time it appears in movie theaters in 2015, showing HD-quality images from an entirely new perspective.

### **Super-intelligent miniature cameras**

The robust INCA miniature cameras developed by Fraunhofer IIS are well adapted for use in extreme environments. They are impervious to dust and sand, resistant to low temperatures, and suitable for helmet-mounted applications. They have proved their mettle in events such as the 2010 world bobsled championships, the "Battle of Raab" world orienteering championships, the DTM German Touring Car Masters (since 2008, in collaboration with Wige Media AG), and the world motorcycle grand prix (since 2010, in collaboration with Vislink), and have even been used in experiments aboard the International Space Station (ISS).

### **Objective analysis of mimicry**

Measuring speed and position is child's play compared with the complex task of reading facial expressions. Human beings have an innate capacity for mimicry, enabling babies to smile from the age of five months, for example. But a smile can signify many things, and it is not always easy to interpret the correct meaning: if only there was an objective means of knowing why someone is smiling. A joint project with GfK Verein, a non-profit think tank belonging to the GfK market research agency, led the Fraunhofer scientists to a new idea.

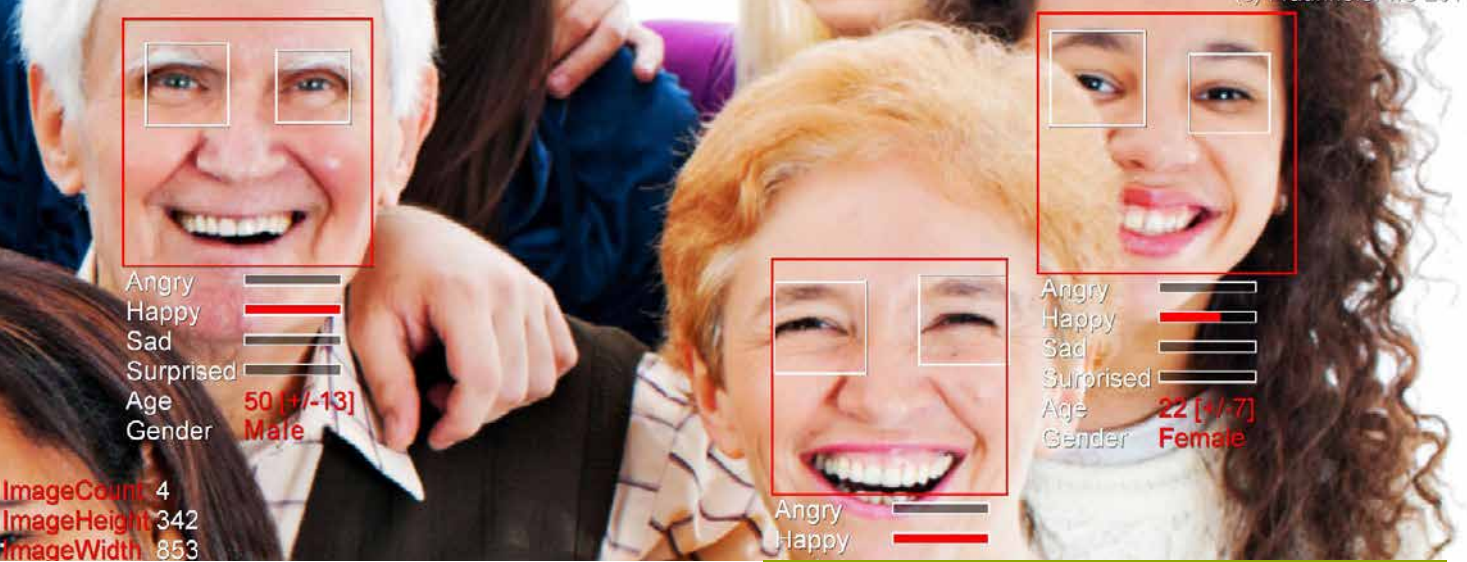
### **Trying to catch that fleeting smile**

Tobias Ruf, a member of the IIS's Intelligent Systems working group headed by Jens-Uwe Garbas, explains: "We have been working together with GfK since 2009. This joint project is about reading the facial signs of emotions. In particular, we want to be able to capture the more subtle micro-expressions that indicate a barely detectable emotion, such as a fleeting smile. GfK was looking for a system capable of objectively assessing the emotional responses of test subjects taking part in advertising impact studies, on the basis of facial expressions.

The SHORE™ software developed by Fraunhofer IIS detects emotions such as happiness or surprise. It works by comparing video images of a test subject's expressions with reference face models. These prototypical reference models are compiled from a database containing photos of thousands of faces. The images of the test subjects' faces are recorded using a webcam and compared with the reference models at pixel level, concentrating especially on areas such as the forehead, eyes, and mouth, which contain most of the information relevant to emotion detection. The algorithms are optimized to permit real-time evaluation."

### **GfK EMO Scan measures the effectiveness of TV commercials**

Tobias Ruf: "GfK EMO Scan is essentially an enhanced version of SHORE™. We started by creating generalized functions for detecting positive and negative moods, to serve as a basis for more detailed analysis. GfK then carried out studies to test EMO Scan's ability to distinguish between positive and negative emotions. For instance, EMO Scan signals a positive response if a person watching a TV commercial laughs or smiles during a humorous part of the advertising message. By contrast, it delivers a neutral result indicating that the commercial has failed to generate an emotional experience (i.e. it is judged to be boring). This gave us the assurance that GfK EMO Scan is capable of measuring the effectiveness of TV



commercials, a result that has since been confirmed in real-life trials.”

In 2012, GfK EMO Scan won the German Innovation in Market Research Award. The jury was particularly impressed by the speed and accuracy with which GfK EMO Scan is able to measure and assess the emotional impact of advertising, without placing excessive demands on the test subjects or invading their privacy. This increases the willingness of the public to participate in market research studies, thus yielding a greater quantity of statistically significant data. Anyone who has a PC equipped with a webcam and Internet access can take part in such studies from the comfort of their own home.

### The advantages of collaborative research

“This joint project involving the GfK Verein and the Geneva Emotion Research Group directed by professor Klaus Scherer is a typical example of the Fraunhofer model,” comments Jens-Uwe Garbas. “We were able to develop a new technology thanks to the financial support of an industrial partner. And for the industrial partner it was a worthwhile investment because it meant being able to offer customers a highly innovative product with great sales potential. Moreover, the interdisciplinary approach made possible by close collaboration with the research group in Geneva resulted in a solution that none of the partners could have achieved on their own – an all-round win-win situation.”

Admittedly, GfK EMO Scan is simply a tool for analyzing exteriorized emotional responses in a specific situational context. We can by no means claim that it allows us to fully understand the complex emotional workings of the human mind. Nonetheless, it will be exciting to see what new knowledge can be gained through the use of imaging technology developed by Fraunhofer IIS, and in what useful ways this knowledge can be applied to enhance our visual perceptual skills.

### SHORT FACTS / CONTACT

*POLKA: A special camera that captures and visualizes the polarization characteristics of light. It is equipped with nano-structured CMOS image sensors with polarization filters and application-specific signal processing algorithms. Operates at high frame rates, delivers razor-sharp images of both static and moving objects, and captures polarization information in a single shot. Weight 350 g. Dimensions 55 x 55 x 75 mm.*

*INCA: An intelligent miniature camera that records HD images and additional information. Based on an OMAP (Open Multimedia Applications Platform) processor with add-on functional blocks for specific tasks. Equipped with a diversity of sensors that deliver data on acceleration, GPS coordinates, air pressure, temperature, heart rate, and facial recognition. Weight: 80 g. Dimensions: 2 x 2 x 8 cm.*

*GfK EMO Scan: Software for the analysis of emotional responses. Based on an enhanced version of the Fraunhofer IIS SHORE™ software combined with a specially developed face detection and analysis tool. Compares webcam images of faces at pixel level with prototypical reference models compiled from a database containing thousands of faces.*

*SHORE™ demo software: [www.iis.fraunhofer.de/de/bf/bsy/pro-dukte/shore.html](http://www.iis.fraunhofer.de/de/bf/bsy/pro-dukte/shore.html)*

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*Highlights*

## **GOALREF**

Goal-line controversies such as that surrounding the 1966 soccer World Cup final look set to be a thing of the past: In the middle of 2012, the International Football Association Board (IFAB) decided to approve the use of goal-line technology. Fraunhofer IIS's GoalRef technology, a system based on magnetic fields, made it into the final round of testing. GoalRef was also used at the FIFA Club World Cup in Japan in 2012. So how does the technology work, what are its advantages and how can soccer benefit from it?



# GOAL OR NO GOAL?

In July 2012, in a move regarded as revolutionary by millions of soccer fans, the IFAB officially approved the introduction of goal-line technology. Along with a technology developed in the UK, Fraunhofer IIS's GoalRef system, which uses magnetic fields, was first used in competitive games at the FIFA Club World Cup in Japan in December 2012. The chief advantage of the GoalRef system is that it collects its data where the action happens: on the ball. Its four components – goal frames, balls, processing unit and referees' watches – are all designed to work together.

## How it all started...

FIFA's decision is revolutionary in that it represents one of only ten or so significant changes that have been made to the rules of soccer since 1886. The approval of decision support systems such as GoalRef is on a par with the introduction of referees or the penalty kick. How did Fraunhofer IIS come into play? In 2003, Danish company GoalRef had the idea for a goal-line technology based on magnetic fields. A few years later, the company approached Fraunhofer IIS, which would soon provide technological support to the Women's Junior World Handball Championship.

June 27, 2010, saw a soccer incident that was to have far-reaching consequences: 37 minutes into a round-of-16 game between England and Germany at the World Cup in South Africa, England's Frank Lampard took a shot, and the ball ricocheted off the crossbar and came down behind the German goal-line. The goal was wrongly disallowed, which many observers believe was the decisive factor in Germany's win. This incident led FIFA and the IFAB to reconsider approving goal-line technology. A formal decision to that effect was reached at the IFAB's annual business meeting in October 2010.

»There are things that the human eye simply isn't equipped to detect,« says René Dünkler, who is in charge of technology marketing at Fraunhofer IIS's Wireless Locating and Communication Systems department. »Soccer only stands to gain from goal-line technologies such as GoalRef, which will bring more justice to the sport.« And so it was that, in 2011, Fraunhofer IIS's system became one of nine to be trialed as

part of FIFA's Quality Programme for Goal-Line Technology. The success of GoalRef speaks for itself: Along with a British camera-based system previously known for its use in tennis, Fraunhofer IIS's solution, which uses magnetic fields, advanced to FIFA's second phase of testing. In July 2012, the IFAB gave goal-line technology the definitive go-ahead. Later that year, GoalRef was licensed by FIFA. The license is a prerequisite for the use of GoalRef in soccer competitions and is valid for two years.

## How GoalRef works

GoalRef is a wireless sensor system that uses low-frequency magnetic fields to reliably determine whether a goal has been scored. According to Law 10 of FIFA's Laws of the Game, »a goal is scored when the whole of the ball passes over the goal line, between the goalposts and under the crossbar, provided that no infringement of the Laws of the Game has been committed previously by the team scoring the goal.« However, when it comes to deciding whether or not the whole of the ball did indeed pass over the line, the human eye is all too often inadequate. This is where GoalRef comes in.

The system comprises four components – goal frames, balls, processing unit and referees' watches – and uses low-frequency magnetic fields which are created in each goal area by a set of ten antennas attached to the goal posts and crossbar. Embedded in the ball are coils that affect neither its weight nor its ballistic properties. As soon as the ball approaches the goal area, a magnetic field is induced around the ball and then interacts with the main field around the goal.



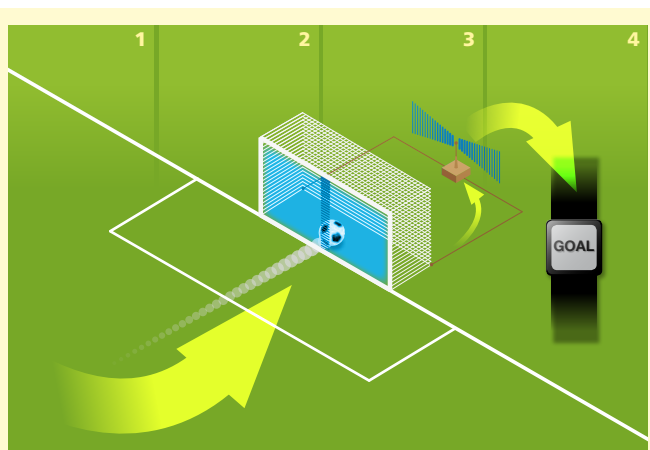
This interaction is picked up by another set of coils attached to the goal frame. By measuring and analyzing the changes in the magnetic field around the goal, it is possible to reliably determine whether the ball has crossed the line completely – because only in that case can a goal be valid under the Laws of the Game. A processing unit running software developed by Fraunhofer IIS interprets the data and produces a reliable result. If the whole of the ball has passed over the goal line, then the fourth and final system component is brought into action: the referees' wristwatches. Each of these receives a text message transmitted by the system. The word »Goal« is immediately displayed on each watch (GoalRef meets FIFA's one-second requirement very comfortably) and coupled with a vibrating alert. The information transmitted is encrypted, so that it cannot be intercepted or tampered with.

Importantly, it is still up to the referee to decide whether to allow the goal, based on whether or not it was scored from an offside position or after a foul by the attacking team. GoalRef merely facilitates the referee's decision-making.

### Experience in sports technology

GoalRef was developed by a large team with members from various Fraunhofer IIS departments. Starting in 2011, the team carried out a great deal of development work and testing. »The success of the project is in large part due to the people who make up our team,« René Dünkler explains. »They're young, committed and quite keen on sports. Even our trainees traveled to the FIFA Club World Cup in Japan. That was an exciting experience.« René Dünkler is glad that the Wireless Locating and Communication Systems department has had the opportunity to contribute to the project: »Our department has been doing research into sports technologies for more than a decade.«

The department has produced ideas for several new technologies. One of these is RedFIR®, which is of potential interest to soccer coaches and broadcasters. RedFIR® is based on a technology for real-time tracking of soccer players and the ball.



Real-time goal detection: It takes less than half a second for a goal alert to be sent to the referees' watches. FIFA allows up to one second for this to happen.

1 The GoalRef system uses antennas to create low-intensity magnetic fields in and around the goal. Embedded in the ball are electronic coils that require no external power supply.

2 As soon as the ball crosses the goal line, it causes slight changes in the magnetic field around the goal. These are detected and the data is analyzed by a processing unit.

3 By interpreting the changes in the magnetic field, the system determines the exact position of the ball. If the ball has fully crossed the goal line, a goal is judged to have been scored.

4 A goal alert is then instantaneously transmitted to the referees using an encrypted radio signal, with a message displayed on their wristwatches.

It makes it possible to recreate game situations, measure physical parameters such as the number of steps taken or movement speed and assess tactical aspects such as a back four's performance.

Over the past few years, the Wireless Locating and Communication Systems department has evolved into a veritable authority on sports technologies.



### **What are the next steps in the process?**

GoalRef is now eligible for use in various leagues and international tournaments. Any system that has been licensed can participate in the tender process. This means that more than one technology may end up being used. On the other hand, providers of currently licensed systems will have to apply for a new license as soon as the underlying technology is modified. "It would be wrong to expect any one technology to emerge victorious and lead to a monopoly on the market," says Thomas Pellkofer, Fraunhofer IIS's business developer for GoalRef. Separate tenders are going to be invited for each tournament or league. Put in soccer terms, every game starts at 0-0. "After all the development work that's gone into GoalRef, we'll obviously be delighted if one of the major international soccer leagues chooses our system," he adds. A commercial company will take care of marketing as well as post-installation maintenance.

From a club point of view, an issue that has yet to be resolved is who will ultimately pay for the installation and maintenance of goal-line technology in stadiums. While systems are licensed by FIFA, any associated costs will be met by the respective soccer leagues. Since goal-line technology delivers a clear benefit, pragmatic solutions will be found for the future. However, the usefulness of GoalRef is by no means limited to soccer. While soccer is without a doubt their top priority, René Dünkler and Thomas Pellkofer are thinking about expanding to other ball sports: "Handball looks promising, too, not least because the system has already been successfully trialed in that sport." We will have to wait and see what the future holds both for Germany's number-one sport and for GoalRef. Time will tell whether the ghost of the 1966 World Cup final can finally be laid to rest.

### **Q & A WITH RENÉ DÜNKLER, TECHNOLOGY MARKETING COORDINATOR**

#### **What is the need for goal-line technology?**

We need a technology that supports referees with difficult decisions. Soccer history has shown time and time again that there are things the human eye simply isn't equipped to detect. The sport of soccer only stands to gain from more accurate refereeing. After all, a lot depends on goal decisions: a lot of money and, in some cases, a club's very existence.

#### **Will goal-line technology replace referees?**

No, definitely not. GoalRef is just a decision support system for referees. It's still up to the referee to decide, based on the situation, whether or not to allow a goal. I like to use the analogy of anti-lock brakes: It's the driver who steps on the actual pedal, the anti-lock system's only there to make things easier for them. The technology behind it used to be exclusive to the high-end market, but is now a standard feature. That's what I envisage for the future of our goal-line technology.

#### **Will players notice anything different about the ball as a result of the coils embedded in it or the magnetic field created around the goal?**

No, not at all. Neither outfield players nor goalkeepers will have to change their game, because neither the ball nor the goal frames will be any different. We ran a huge number of tests to be able to say with absolute certainty that GoalRef doesn't affect the game in any way.



### **Who will bear the costs of equipping stadiums with GoalRef?**

That's a question that has yet to be definitively answered by soccer's decision-makers. Our next step will be to make leagues and competition organizers attractive, individualized offers.

### **What advantages does GoalRef have over other systems?**

GoalRef is literally on the ball. It collects data where the action happens, that is, on the ball and around the goal. Also, being based on magnetic fields, GoalRef works perfectly even when the ball is obscured from view. This ensures total reliability even in melee situations such as corner kicks or when a goalkeeper or outfield player is smothering the ball. Finally, GoalRef is compact and easy to install, which means no stadium will need to be modified.

### **What are your plans and expectations for the immediate future?**

We're now entering the marketplace and we hope to see GoalRef used in a number of leagues and tournaments. The groundwork is in place and we're more than confident that GoalRef will conquer soccer and other sports.

## SHORT FACTS / CONTACT

### *GoalRef timeline*

*2003: Danish company GoalRef has the idea for the technology of the same name.*

*2007: The company approaches Fraunhofer IIS.*

*2008: GoalRef is used at the Women's Junior World Handball Championship in Macedonia.*

*2011: Fraunhofer IIS acquires the rights to the technology and adapts it for use in soccer rather than handball.*

*2011: FIFA launches the first phase of testing with products from nine providers.*

*March 2012: GoalRef advances to the second phase of testing (trials under more demanding conditions and in games).*

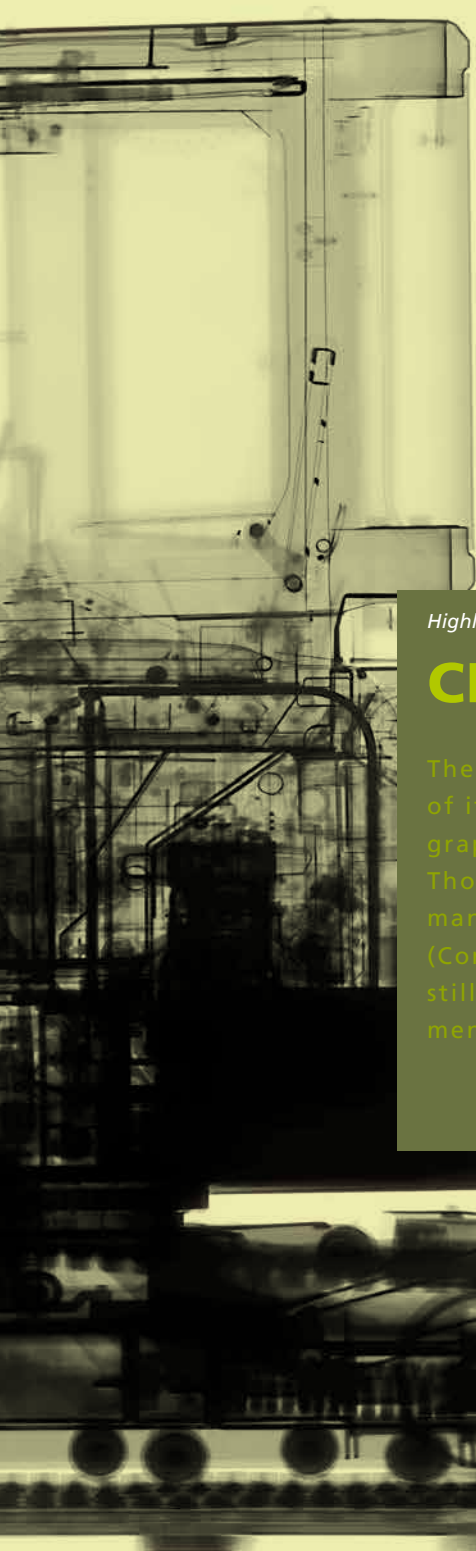
*July 2012: IFAB modifies the Laws of the Game, officially introducing goal-line technology.*

*October 2012: GoalRef is officially licensed by FIFA.*

*December 2012: GoalRef is used at the FIFA Club World Cup.*

*Dipl.-Wirtsch.-Ing. René Dünkler, Phone +49 911 58061-3203,  
rene.duenkler@iis.fraunhofer.de*





*Highlights*

## **CREATING TRANSPARENCY**

The city of Fürth, Germany is where Fraunhofer IIS has concentrated most of its expertise in the fields of X-ray sensor technology, computer tomography and X-ray image processing and applications. We spoke with Thomas Wenzel (Process-integrated Inspection Systems), Norman Uhlmann (Development Center for X-ray Technology EZRT) and Peter Schmitt (Contactless Test and Measuring Systems). Schmitt's department, which is still located in Erlangen, will move in together with the other departments in the new building in Fürth-Atzenhof in the summer of 2013.

*Radiograph image of a real excavator taken by the Fraunhofer EZRT in Fürth-Atzenhof.*

# OF FOODSTUFF FOAMS AND LIGHT ALLOY WHEELS

What do cappuccino foam and light alloy wheels have in common? At first glance, not a thing. Surprisingly, the Fraunhofer Institute for Integrated Circuits IIS is involved in both. Using time-resolved computer tomography (4D CT), researchers are examining the dynamic behavior of foodstuff foams, work that contributes to better tasting foods — a broad field in the food processing industry. Another team developed a more efficient and fully automated process for detecting flaws in light alloy wheels. The automobile industry partners are enthusiastic.

## INTERVIEW WITH THOMAS WENZEL, NORMAN UHLMANN AND PETER SCHMITT

### What were 2012's most successful projects in your opinion?

*Norman Uhlmann:* One of the X-ray development center's most outstanding and technically challenging projects is referred to as the CBI System. This involved developing and implementing a computer tomography (CT) system from the ground up to carry out time-resolved flow analyses of the liquid phases in chromatography columns.

### What are the special challenges for using a CT system in this environment?

*Norman Uhlmann:* CT systems let you create 3D data sets of any object. To do that, you have to take radiographic images of the object from all sides. In non-medical applications, the object is usually rotated at intervals between the individual images. We were unable to use this approach for this project however. By rotating the chromatography column, the additional centrifugal force would have impacted the phases and distorted the results. And due to the connections the column required for this experiment (the liquid phase is compressed by the stationary phase by applying high air pressure), fast rotation of the column was not possible. That forced us to use a Gantry system.

### What challenges did you face with this project?

*Norman Uhlmann:* With a Gantry system, the CT equipment records the images by rotating around the object to be examined. Because of the time resolution we wanted to achieve,

the X-ray components and the data recording processor had to rotate around the column once per second. The system captures 1,000 individual images during this timeframe and transports the data to the reconstruction and visualization processor using sliding contacts. The key here is making sure the rotation and image recording are exactly in synch. For this project, that meant ensuring that all facets of the system were precisely in tune and optimized at the component and system level, whether it was machine engineering and design, X-ray tubes and detector, machine controls or the software for system control, image recording, reconstruction, correction processes and display. The Chair of Separation Science and Technology at Friedrich-Alexander University in Erlangen is able to display and analyze the spatial distribution of the liquid phase in the stationary phase despite minimally-different densities that are time-resolved based on various process parameters. What's unique here is that in addition to the spatial display, the chronology of the process is also visualized (3D (spatial) + 1D (time) = 4D CT).

### Why are customers coming to you instead of a CT system manufacturer?

*Norman Uhlmann:* That's a valid question. Meanwhile, there are many manufacturers of CT systems for non-medical applications. The issue is, there are few — and in this case probably none — that are in a position or see a need to develop and build systems for special applications. These systems require a lot of development and adaptation effort and that carries with it corresponding risks that industrial CT manufacturers are reluctant or not willing to bear at all. This is where we see

our strengths however; offering customers special solutions optimized for their application scenarios. Merely duplicating existing systems is not the Fraunhofer way and that would quickly become boring.

**You mentioned the term 4D CT. Is that the only project associated with this topic?**

*Norman Uhlmann:* Not at all. Apart from statistical representation, we've been investigating ways to capture and analyze the temporal development of structures for a long time now. The range of applications and issues related to 4D CT are just as broad as those for »normal« 3D CT.

We are currently working on a project that is examining the decomposition of foodstuff foams. The structure of the foam plays a large role in how foodstuffs such as Espresso or Cappuccino appear and taste. That's why reconstructing and analyzing the development and decomposition of foams is a field of research in the food industry. If manufacturers understand more about how the foam develops and decomposes, they can also influence how the foodstuff tastes.

Apart from the food industry, many materials developers also have an interest in the analysis of 4D structures. Five years ago, we worked on a project that analyzed how cracks form and expand in various metal alloys used in the automobile and aerospace industries. The first experiments involved setting up a commercial truck tractor in our high-resolution CT system to perform tensile strength tests. We were able to create a stress-strain diagram for various alloys while simultaneously performing CT measurements. Using the displacement data from the tensile strength analysis, we were able to predict where the crack would appear before it formed.

**Mr. Wenzel, what was your highlight of the previous year?**

*Thomas Wenzel:* We worked together with the Contactless Test and Measuring Systems department and an external partner —Erhardt&Abt — to develop and bring to market a new system for the automatic X-ray inspection of light alloy

wheels. By combining a detector (XEye) with outstanding properties (Contactless Test and Measuring Systems), the ISAR inspection system that sets new benchmarks in automatic X-ray testing (Process-integrated Inspection Systems), plus an innovative handling system, we created a solution that exceeds the benchmark data of all systems developed to date by a wide margin.

**How do you actually inspect the wheels?**

*Thomas Wenzel:* Wheel inspection involves the fully automated analysis of light alloy wheel castings directly after the casting process in order to detect defects such as blow holes — or hollow cavities that form during solidification — and inclusions. The process is divided into two tasks. The first involves the automated manipulation of the object being inspected, in this case the light alloy wheel. Since this is a raw mould and because the outer dimensions of the wheel exhibit relatively wide variances due to machine tolerances and casting flash, the gripping concept has to be extremely robust to counter these influences. The inspection, which is broken down into individual steps, also has to be carried out at high speed. X-ray images are taken of the wheel as it's brought into a series of different positions. The time it takes for the process to switch from one position to another has to be minimized.

**How does your new process differ from those already on the market?**

*Thomas Wenzel:* The second part of the process is the X-ray inspection itself. The objective is to capture a high-quality image of the wheel in each position and then automatically analyze it with inspection software. In order to reduce the overall inspection time as far as possible, it's important to analyze as much of the wheel surface as possible with an image. This lets you minimize the number of inspection positions required for each wheel.

*Peter Schmitt:* The XEye detector developed by the Contactless Test and Measuring Systems department is an ideal



Wheel at the ingress to the inspection system

choice for wheel inspection because it has a high dynamic range providing the simultaneous representation of very small and large wall thicknesses as well as an optimal format covering a large area of the wheel in an X-ray image. This is a genuine innovation in the area of wheel inspection.

#### **How are the generated images analyzed?**

**Thomas Wenzel:** The ISAR inspection system is responsible for automatically analyzing the X-ray images. The inspection software ensures that the system detects any defects that violate a predefined quality criterion and cause the wheel to be rejected. It also has to ensure that it only detects real flaws in the material. Other structures in the alloy casting regularly lead to erroneous readings — called pseudo defects — and unnecessary rejection of the die cast part. ISAR features a classification method unique in the field of X-ray technology, which when compared to equivalent systems significantly reduces these pseudo defects.

#### **What is the significance of this project for your department?**

**Thomas Wenzel:** My department has a group of six people devoted exclusively to the development and enhancement of the ISAR inspection system. Although wheel inspection is just one of the fields of application, which also includes the inspection of other vehicle body parts, it nonetheless accounts for 50 percent of the group's research budget. Besides working with Erhardt&Abt in the area of wheel inspections, the department cooperates with other partners in other fields of application, including MatriX. These partners are exclusively system integrators who offer the end customer complete solutions. Customers who deploy our system include Volkswagen Braunschweig, KSM Castings and Borbet among others.

**Peter Schmitt:** The Contactless Test and Systems department has continually developed the XEye X-ray camera for

around ten years. We currently have 10 people dedicated to this system. These X-ray cameras are used wherever X-ray systems are operating around-the-clock, such as the inspection of die cast parts, welding seams, foodstuffs or in electronics manufacturing. In these fields of applications the main benefits of the XEye come to full advantage, while other commercially-available X-ray cameras fail to meet the customers' requirements. In contrast to all other X-ray cameras, the custom construction eliminates the possibility of radiation-induced damage to the camera electronics. The X-ray cameras contribute to nearly 50 percent of the department's project volume.

#### **To conclude with your outlook, what are the key projects for 2013?**

**Norman Uhlmann:** In my opinion, 2013 will be a very exciting year. Several areas have key projects for a variety of applications and technologies. Whether it's examining the possibility to inspect wind turbine rotor blades, the feasibility of detecting diamonds in rough stone, or the completion of the ECSIT project, in which the feasibility of creating 3D images of entire sea freight containers is being evaluated, radiosopic imaging will continue to keep us extremely busy over the next few years. We continue to be amazed at the types of tasks and issues that crop up over the course of a main project. The artist Nick Veasey ([www.nickveasey.com](http://www.nickveasey.com)), a specialist in X-ray art, recently paid us a visit for instance. I'd like to conclude by quoting something he said when he saw our capabilities in Fürth-Atzenhof: »This is heaven...«

**Thomas Wenzel:** Our work in the inspection of die cast parts is taking us beyond light alloy wheels. This increasingly involves a process that can supply a three-dimensional image of the part being inspected, which makes the inspection results much more meaningful. This process is the same computer tomography technology that established itself in laboratory applications over the past decade. Our challenge is bringing this technology in line, which involves speeding





*View of the tire inspection system manipulator*



*At work in the foundry: wheels lining up for inspection*

up the CT and thus adapting it to the production cycle. We're developing processes that permit extremely fast capture of the required data. We're also working in the field of mathematics in order to create optimal 3D reconstructions from small volumes of image information and automatically analyze them in the production cycle. These challenges, and the associated solutions, will be the focus of our activities in 2013.

**Peter Schmitt:** The X-ray cameras represent just one focus of the department. Another is optical 3D inspection systems. These systems, like the X-ray cameras, operate around-the-clock and for this reason, they must function without interruption. As an example, we developed final inspection systems for tire manufacturers, which system partners supplied as far as China and Vietnam. More than 150 of these systems are in use. In the area of optical 3D inspection systems, the Fraunhofer Foundation »Malaria« project illustrates a new challenge. The aim of this joint project, which involves the Fraunhofer IME and Fraunhofer IPT institutes, is the fully-automated production of malaria vaccines in tobacco plants. The department has been tasked with creating three-dimensional, color images of the plants and using this measurement data to draw conclusions about the health of the plants.

## SHORT FACTS / CONTACT

*Peter Schmitt has been active in a variety of positions at Fraunhofer IIS since 1992 and has been head of the Contactless Test and Measuring Systems department since 2003. His research activities focus primarily on optical 3D inspection systems and radiation-resistant X-ray cameras for industrial applications.*

*Norman Uhlmann has been active in a variety of positions at Fraunhofer IIS since 2005 and has been head of the Development Center for X-ray Technology since 2010. His research activities focus primarily on the development of new materials analysis methods, the fields of radiation and safety, and also recycling and biology.*

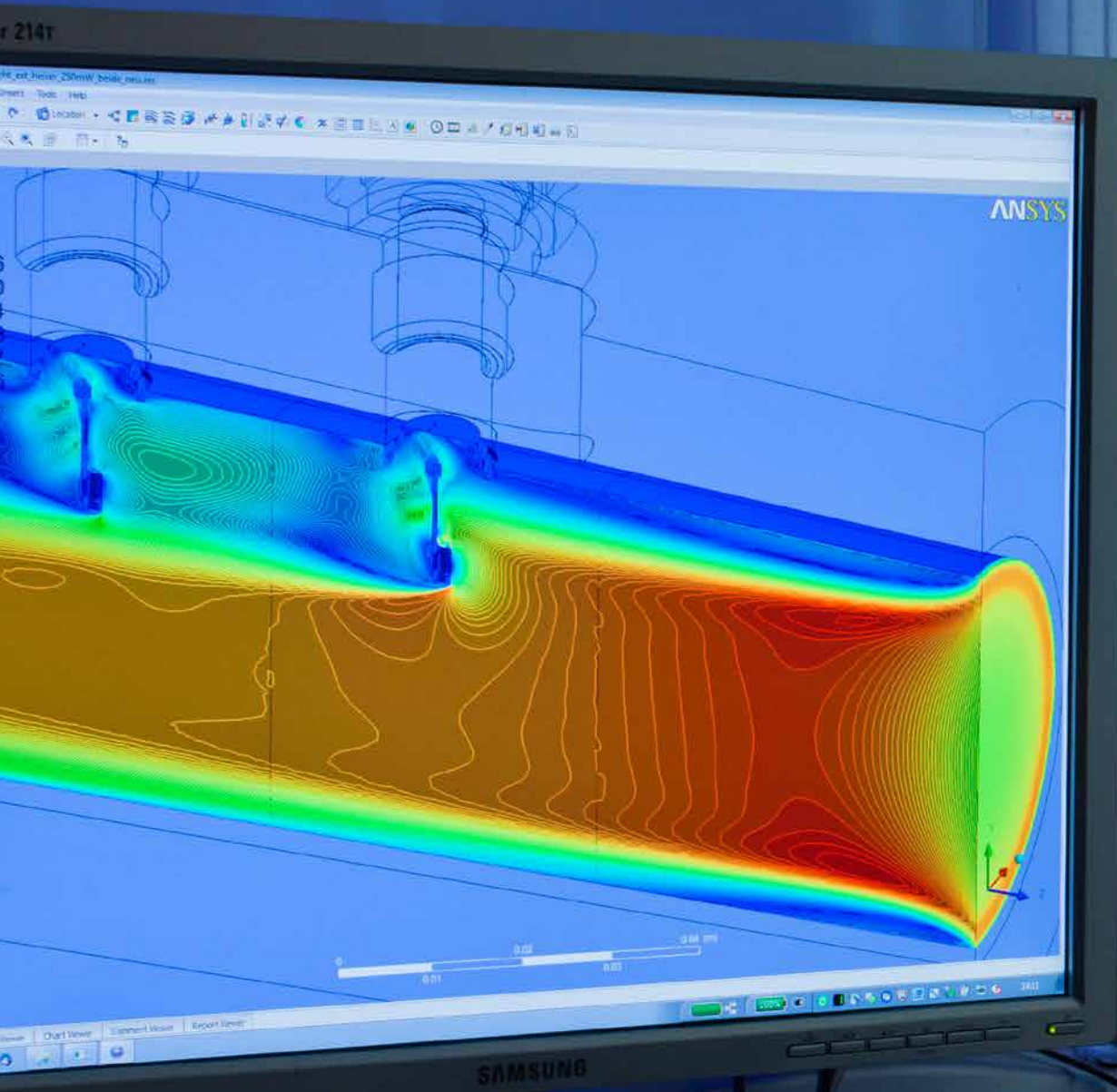
*Thomas Wenzel has been active in a variety of positions at Fraunhofer IIS since 1993 and has been head of the Process-integrated Inspection Systems department since 2009. His research activities focus primarily on image processing technologies for the automatic analysis of radiographic images and the field of computer tomography.*

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### Highlights

## 20 YEARS OF THE EAS DIVISION IN DRESDEN

Technical products are becoming more and more complex: Today's cars can brake by themselves if danger arises, and our dryers can detect how wet the laundry is automatically. To master the challenges in developing technical systems of this type, Fraunhofer IIS integrated a Dresden-based research group on design automation into the institute in 1992. On the 20th anniversary of what is now a division of the institute, we asked the director, Dr. Peter Schneider, what has changed since the early days and which tasks still lie ahead.

# MICROELECTRONICS AND DESIGN AUTOMATION – 20 YEARS OF INVENTIVE TALENT

The Fraunhofer Institute for Integrated Circuits IIS can be found in Dresden, too – at Europe's largest microelectronics location. Developments in this sector make it clear that the design automation division located there is in a constant state of development and change. Dr. Peter Schneider, acting director of the institute's Design Automation Division EAS, has been there almost since the beginning. We took advantage of the 20th anniversary to ask him about the past as well as future plans and challenges – for him personally and for the future of EAS.

## INTERVIEW WITH DR. PETER SCHNEIDER

### **What does working at Fraunhofer mean for you?**

I find Fraunhofer's principle of applied research to be a unique challenge. The necessary close contact that scientists in the Fraunhofer-Gesellschaft maintain with industry is, for me, the outstanding aspect. It is very special for a researcher to see his or her own work make a contribution to improvements or new developments in industry and be recognized by people even outside the scientific community.

### **The EAS division is concerned with the topic of design automation. What does that mean and what are the focuses of your work?**

Today's technical systems are made up of many different components that are getting more and more complex. It starts with ordinary household appliances and also includes cell phones or the assistance systems found in modern cars. Another complicating factor is that these systems interact with their environment in a more and more multilayered manner. Planning and developing them to be reliable is therefore no longer possible without computers. The various methods and processes used are referred to collectively as electronic design automation or EDA. The work of our division lies largely in supporting companies on their journey from a new idea to a finished product. On the one hand, this refers to the function of a system, i.e. the question »Will this product do what it's supposed to do?« We are able to answer this question during the development stage of complicated technical arrangements. On the other hand, other influencing

factors – such as variations in the manufacturing process or environmental factors – must also be taken into account. For this focus of our work, we use and develop powerful software to design well-functioning systems quickly and safely. The skills we can offer here and which are called for in the design tasks we perform for our customers also form the basis for our own developments. We are currently focusing on innovative sensors and system solutions, such as sensor networks for conditioning monitoring of plants or energy management systems in buildings or production.

### **In 2012, the EAS division of Fraunhofer IIS turned 20 years old. You have worked in this Fraunhofer organization since 1993, so almost from the start. What has changed the most since the beginning?**

In the early years, when we were still a branch lab of the Fraunhofer Institute for Integrated Circuits IIS, the work in our division was organized very methodically and was concerned almost exclusively with microelectronics. Our research nowadays is much more application-related and we have expanded our spectrum to include microsystem technology, mechatronics, and automation technology. The number of employees was also much smaller 20 years ago. Compared with the 30 scientists we had then in four specialist groups, we now have a permanent workforce of more than 90 in ten groups. The most important factor affecting our area, however, has been the rapid technical development in computer and communication technology and the role they play in working life. To take a good example: in the early 90s there

were just a few Sun workstations for each specialist group. In order to use them, you had to reserve computer time in advance. That's just impossible to imagine with today's omnipresent computer technology and the options we have to work remotely.

**In addition to these fundamental changes, I'm sure there have also been some personal highlights during your time at Fraunhofer IIS/EAS?**

Helping to shape topics and to disseminate them internally are some of my personal highlights. I am thinking in particular of the area of heterogeneous systems, which comprise not only pure electronics, but also other non-electric components. At the beginning, this topic was just a little acorn in our division. In 2000, we then had a working group, which I led, and then, six years later, a department. During these few years, I was lucky enough to be able to work with my colleagues on trendsetting developments. This led, for example, to a new generation of design methods for the automobile industry. The latest highlight for me, of course, has been my appointment to the directorship of the division.

**That was in 2011. How did you find the first few months in your new job?**

If I had to put it briefly, I would say: very exciting! Switching from directing a department to directing the division naturally meant a lot of new tasks. At the same time, I was still handing the department over to my successor. That was a very intensive process. Naturally, I had to learn to grow with my new tasks at the beginning, and only then really came to understand what the previous director of the institute, Günter Elst, did for us from 1992. I still take my hat off to him. Another challenge was the fact that the new structures were connected to a certain „re-sorting« of specialist topics in the division. That meant new impulses for cooperation, not only for me, but also for all my colleagues.

**What do you now like most about the directing tasks for Fraunhofer IIS/EAS? And do you miss your earlier daily**

**work in research?**

To answer the second part first: I do indeed miss research. Particularly in my early days as director of the division, research really had to take a back seat. I would like to be able to change that in the future and not to lose sight of my own scientific profile. It is important that I be able to unite the two successfully. The most interesting thing about my position as director is that it means preparing the division for upcoming developments and, in a way, designing its future. That is both a challenge and an incentive and can only be successful if there is close discussion with colleagues about the direction of our specialist work.

**What trends do you see for EDA and therefore for the work you do?**

One of the most important topics for the future will definitely be the ability to continue mastering systems that will get more and more complex. The successful combination of hardware and software, sensors, actuating elements, and electronics is therefore becoming more and more important, as is the interaction between humans and machines.

Furthermore, there will continually be new developments in the manufacturing processes for technical products. This will make them smaller, more innovative, and more powerful. On the other hand, however, new technologies can lead to uncertainties that may decide the success of products and companies early in the development stage. One example of this from our work can be seen in current manufacturing processes for vias through silicon layers. They allow three-dimensional stacking of microchips and other components, which then can be used as miniature sensor systems in medicine, perhaps. This technology, however, presents developers with new questions regarding the concrete structure of the systems or the optimum manufacturing process. This is where we can bring in our knowledge.

Another trend I have identified is that the general development in computer technology yields potential for further automation of more and more steps when developing systems.



Dr. Peter Schneider

In digital technology, this is already a reality, and the future will bring similar developments in the development of analog circuits or sensors. I am also convinced that, in the future, a holistic approach in system design will become essential. To ensure safe product development, various physical domains within systems must be observed together at early stages of planning. Today, this is often not the case, which frequently results in failures or delays in development. That must change in the future in order to increase efficiency, quality, and reliability.

**What chances do you see as a result for Fraunhofer IIS/EAS?**

Naturally, we must take these trends into account in our work and provide good, interesting, and practically useful solutions to industry as quickly as possible. If we also manage to apply our great skills to even more technological developments, we can find an efficient path to many innovative solutions. That, coupled with directing our research at the right gaps in the market, will ensure that our division can develop in a sustainable manner.

**How do you imagine your division on its 30th birthday? What role will Fraunhofer IIS play?**

I hope that our Dresden division will still be an important member of the IIS family. Even today, many of our application-oriented focuses are closely linked with the other Fraunhofer IIS locations. But this cooperation is sure to strengthen even further in the future. Our division will then be standing on a firm foundation of three pillars. Design automation will continue to be adapted to companies' current requirements. EDA can also give us positive impulses for our own developments and to steer them even further into application-oriented fields of research. We should

also continue to apply our skills to open up new areas of research. That will allow us to continue to grow moderately until 2020.

**What do you wish for from your employees?**

The positive development in the last 20 years is largely down to the skill and creativity of the division's employees. Their joint work on future products strengthened and promoted our success. I would like to thank them once again for this! For the future, I wish that we all take the best possible advantage of the chances offered by a globalized world – which includes the scientific world. The success of our division remains a joint task. Each of us must take responsibility for promoting his or her field and network effectively with colleagues, here, at Fraunhofer IIS, and beyond.

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**Celebrations to mark 20 years of Fraunhofer in Dresden**

On March 2nd, 2012, the Fraunhofer institutes and divisions in Dresden – including EAS – invited guests to celebrate their 20th anniversary. Fraunhofer staff joined customers, partners, funding providers, curators, and those who accompanied them on their journey, in the airport terminal. Guest speakers included, in addition to the Saxon premier Stanislaw Tillich; the then-President of the Fraunhofer-Gesellschaft, Prof. Hans-Jörg Bullinger; the First Mayor of the city of Dresden, Dirk Hilbert; the chairman of the Fraunhofer-Zukunftsstiftung, Dr. Alexander Imbusch; and the president of the TU Dresden, Prof. Hans Müller-Steinhagen.



## SHORT FACTS / CONTACT

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*Facts about the Design Automation Division EAS*

*Director (acting): Dr. Peter Schneider*

*Founded: 1992*

*Employees (as of 2012): 93*

*Operating budget: € 7.3 million*

*Business units: microelectronic systems, automation systems, sensor systems, and actuators*

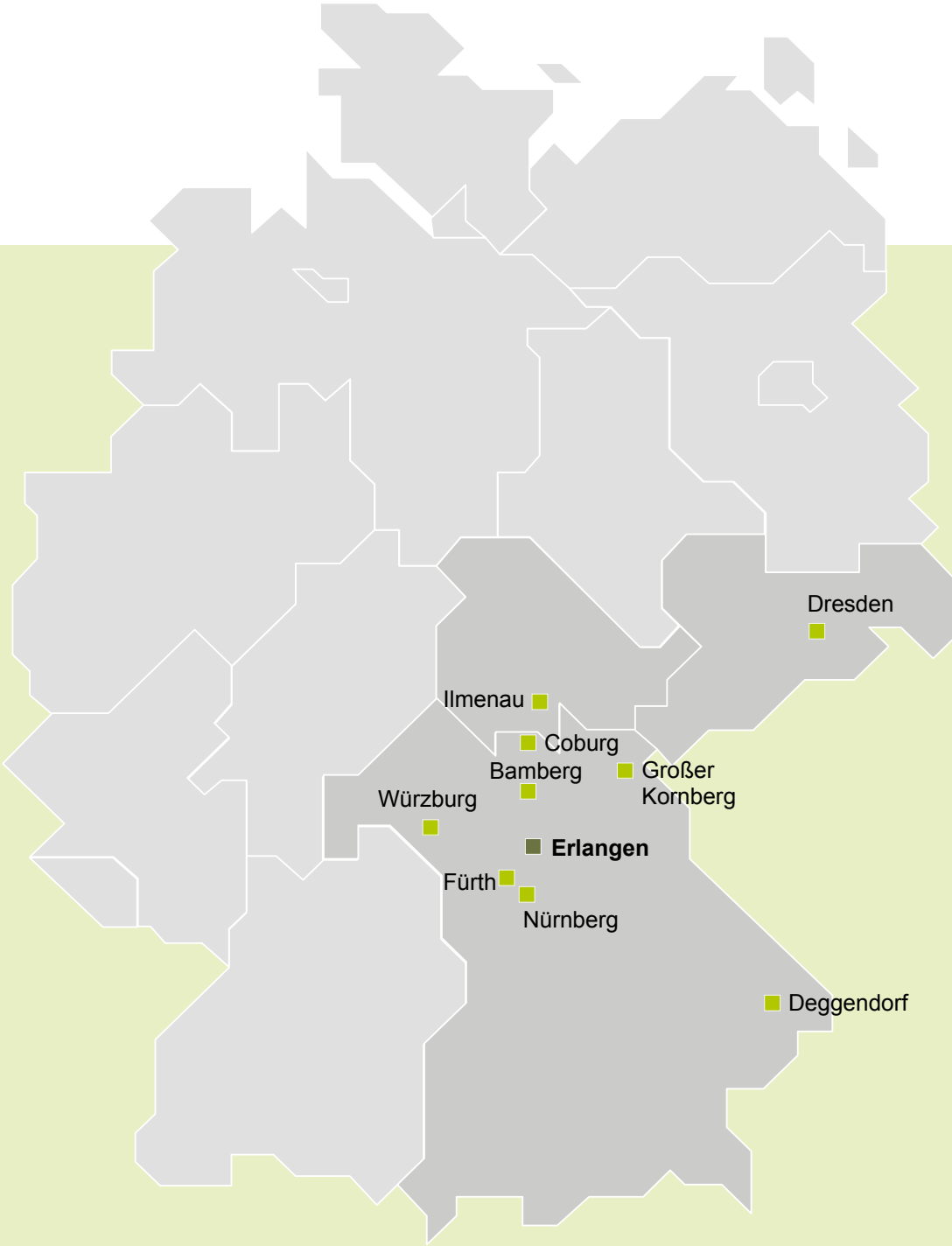
*Research topics: system development, technology-related modeling, system integration, design services, image sensors, magnetic sensors, sensor networks, condition-monitoring systems, energy management, logistics systems*

*Dr.-Ing. Peter Schneider, Phone + 49 351 4640-710,  
peter.schneider@eas.iis.fraunhofer.de*









# THE INSTITUTE IN PROFILE

The Fraunhofer Institute for Integrated Circuits IIS, headquartered in Erlangen, was established in 1985. Today, with additional locations in Nürnberg, Fürth, Ilmenau, Würzburg, Dresden and Bamberg, it is the largest institute of the Fraunhofer-Gesellschaft. Fraunhofer IIS is known around the world thanks to its significant contribution to the development of the mp3 and MPEG-AAC audio coding standards. The Institute's staff of 750 scientists develops software, microelectronic circuits, devices and systems, including complete industrial automation solutions, for applications in the fields of microelectronics and information and communication technology.

## Correlation of business fields and locations

Business field / Location	Erlangen	Nürnberg	Fürth	Ilmenau	Würzburg	Dresden	Bamberg
IC Design and Design Automation	●	●				●	
Audio, Video and Multimedia	●						
Digital Broadcasting	●			●		●	
Communication Networks		●		●			
Imaging Systems and Quality Assurance	●		●		●	●	
Navigation, Localization and Robotics		●					
Embedded Systems	●	●				●	
Logistics and Supply Chain Services		●	●				●
Medical Technology	●						
Energy Management	●	●		●			
Defense and Security	●	●	●	●			

Research and Development

Studies

Joint Venture

Licensing

# FRAUNHOFER IIS – A PARTNER FOR INDUSTRY

WHAT WE DO FOR OUR CLIENTS

## Who we are

The Fraunhofer Institute for Integrated Circuits IIS is a world leader in applied research. Developing and providing microelectronic and IT system solutions and services, Fraunhofer IIS makes important contributions to Germany's technological leadership.

A wide range of technologies, methods and processes are employed to generate innovative solutions, ranging from components to complete systems, which keep our clients in industry competitive and successful.

In conjunction with a network of international partners, Fraunhofer IIS conducts top-level research for the immediate benefit of industry and the greater good of society. The innovative and practical technology solutions Fraunhofer IIS develops for its clients are instrumental in increasing the competitiveness not only of the Nürnberg metropolitan region, but also of Germany and Europe as a whole.

## Our range of services

Fraunhofer IIS is a valued partner to a large number of businesses. Our staff is familiar with the needs of our clients in industry and works with them to create tailored, innovative solutions.

Choose from the following services to help maintain your competitive edge:

- Technology consulting
- Custom adaptation of Fraunhofer-developed technologies
- Contract research and prototyping
- Analysis, studies and design concepts
- Testing and measurement techniques
- Finding and liaising with partners for projects and semiconductor manufacturers

# ADVISORY BOARD

The Advisory Board supports the administrative bodies of the Fraunhofer-Gesellschaft and the institute directors, and helps to forge contacts with industry and related organizations. The members of the Fraunhofer IIS Advisory Board are:

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Dr. Annerose Beck  
Saxon Ministry of Science and Arts

---

Jürgen Beuthner  
TechniSat Digital GmbH

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Dr. Gerd-Achim Gruppe  
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Klaus Helmrich  
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# CONTACTS

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Dr.-Ing. Bernhard Grill  
Deputy Director

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Prof. Dr.-Ing. Randolph Hanke  
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Dr. rer. pol. Peter Dittrich  
Director administration, finance, human resources

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Director (acting)

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Dr.-Ing. Andreas Wilde

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Microelectronic Systems  
Dr.-Ing. Manfred Dietrich

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**Projekt Goups**

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Nano X-ray Systems for Material Characterization  
Prof. Dr.-Ing. Randolf Hanke

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Application Center Wireless Sensor Systems  
Prof. Dr. Thomas Wieland

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Application Center CT and Metrology  
Prof. Dr.-Ing. Randolf Hanke (acting)

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Administration Nürnberg  
Dipl.-Betriebswirtin (FH) Regina Kühn

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Administration Fürth  
Dipl.-Kauffrau Colett Rißmann

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Administration Dresden  
(Division Design Automation Dresden EAS)  
Petra Lewenhardt

---

IT Services  
Dr.-Ing. Roland Plankenbühler









### Human resources, operating and investment budget

The operating results of the Fraunhofer Institute for Integrated Circuits IIS in 2012 reflect the influence of the economic upturn in Germany. Following a slowdown in growth around the end of 2011, German industry began to move ahead again. This had a tangible effect on the volume of new contracts received by Fraunhofer IIS.

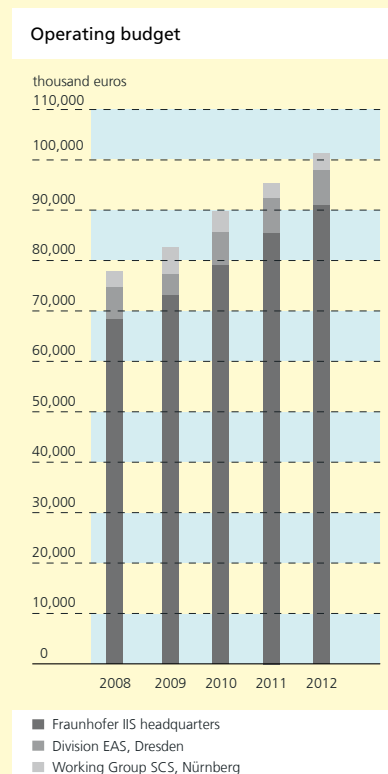
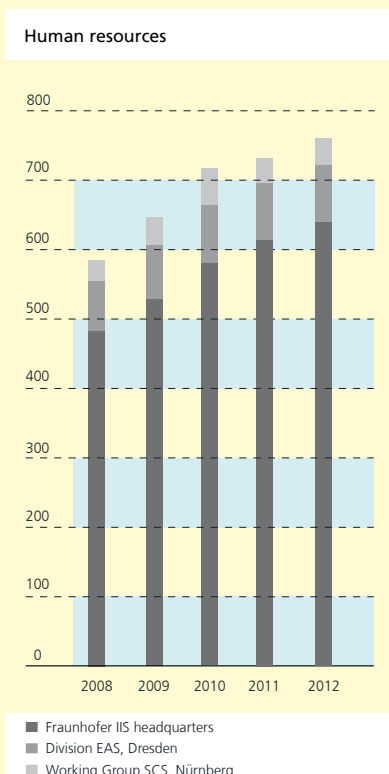
#### Human resources

As in previous years, Fraunhofer IIS expects staff levels at its locations in Erlangen, Dresden, Nürnberg, Fürth, Ilmenau, Würzburg and Bamberg to grow at a moderate, sustainable rate.

### Operating budget

Fraunhofer IIS is currently in the process of building up a number of new research areas. In keeping with the Institute’s mission, the ultimate objective is to translate the results of this research into real product applications.

Fraunhofer IIS finances its activities on the basis of the Fraunhofer model. Hence its operating budget comprises basic funding through the Fraunhofer-Gesellschaft (27 percent), revenues from commercial and industrial projects (50 percent), and project revenues from public funding and other sources (23 percent). Given the present volume of contracts, Fraunhofer IIS expects to balance its operating budget for 2013, as in previous years.

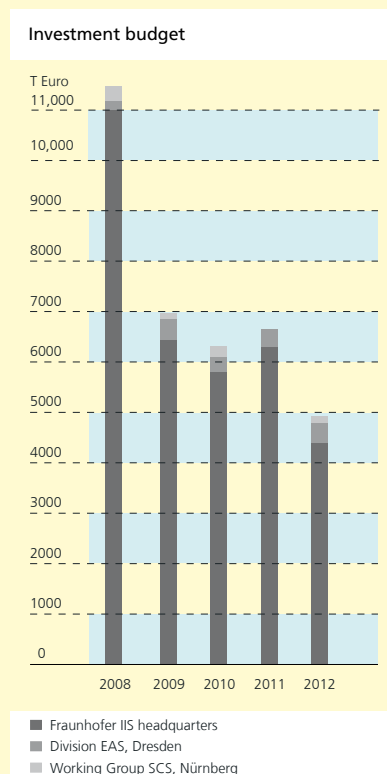
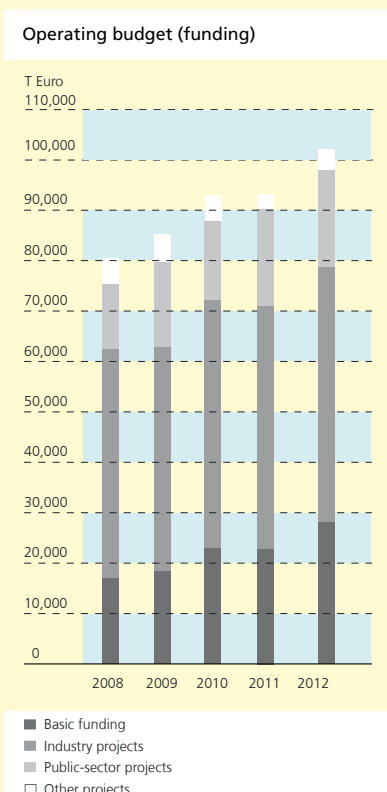


### Investment budget

In addition to highly qualified staff, continuous investments are necessary to sustain the Institute's position in the competitive global market for research services. In accordance with the profile of the Institute, capital expenditure on computer hardware and software, including advanced design software and high-performance data networks, constitute the main expense items.

The investment budget is covered by amounts allocated from basic funding and project revenues, supplemented by income from licensing agreements. The higher-than-average capital expenditure in 2008 was due to initial equipment expenses

for the second construction phase of the new headquarters building, which was inaugurated that year.



## Editorial Notes

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Prof. Dr.-Ing. Albert Heuberger

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