The Fraunhofer Institute for Integrated Circuits IIS





Overview

- The Fraunhofer-Gesellschaft
- The Fraunhofer Institute for Integrated Circuits IIS
- Business Areas and Research Examples



Joseph von Fraunhofer (1787 – 1826)



Scientist

Discovery of Fraunhofer lines

ULTRA VIOLET L-RATS GAMMA RATS

in the solar spectrum

Inventor

New methods of making lenses

Businessman

Managing partner of a glassworks





The Fraunhofer-Gesellschaft Today



Institutes undertaking related research are organized

in Fraunhofer Groups:

- Information and Communication Technology
- Life Sciences
- Microelectronics
- Surface Technology and Photonics
- Production
- Materials and Components
- Defense and Security



Fraunhofer-Gesellschaft

The Fraunhofer-Gesellschaft in Figures

- Founded in Munich in 1949
- 57 institutes across Germany with a total staff of 15,000
- Five Fraunhofer Centers in the USA
- Representative Offices and Senior Advisors in Asia, in the Middle East and in Moscow
- Total budget €1.4 billion with approx. 60% of income generated from contract research and governmentsponsored projects





The Fraunhofer Institute for Integrated Circuits IIS



- Founded in 1985
- Approx. 600 staff
- Budget: approx. €72 million
- Revenue sources:
 > 80% income from projects
 - < 20% public funding















Fraunhofer IIS Business Areas

- Audio und multimedia technologies
- Imaging systems
- Digital broadcasting systems
- Embedded communication
- IC design und design automation
- Communication networks
- Navigation
- Logistics
- Medical technology
- Optical inspection systems
- X-ray technology



Fraunhofer IIS – Home of mp3



History of audio coding in Erlangen

Since 1981 Audio coding research at FAU Erlangen-Nuremberg Since 1987 Work on audio coding at Fraunhofer IIS 1992 MPEG-1 Layer 3 (mp3) adopted as international standard 1997 mp3 rapidly gains popularity 1997 MPEG-2 AAC successor format international standard 1999 mp3 as de-facto standard for music on the i-net 2000 mp3 wins Future Prize awarded by German President 2007 Suzanne Vega meets mp3 developers







Real-Time Multimedia Systems



Movies in your pocket – video with outstanding image and sound quality for cell phones and PDAs

Combination of audio and video coding methods

- MPEG-4 High Efficiency Advanced Audio Codec (HE-AAC) audio compression and MPEG-4 Advanced Video Codec (AVC/H.264) video compression
- Excellent stereo sound at data rates as low as 48 kbit/s and QVGA-resolution (320 x 240 pixels) video at data rates as low as128 kbit/s



The Radio of the Future



- EUREKA 147 DAB Digital Audio Broadcasting
- DRM Digital Radio Mondial
- WorldSpace Satellite Radio, mobile WorldSpace
- XM Satellite Radio for North America
- Sirius Satellite Radio for North America
- Ku-Mobil
 - Ku-band satellite transmission of multimedia content to car radios
- DVB-T/-H/-S/-SH Digital Video Broadcasting



Camera and Video Systems for Use in Quality Control and Motion Analysis



High-speed camera



Micro HDTV camera



Imaging Systems

Digital Cinema

High resolution digital filmstyle camera ARRI-D20 and Tools for Postproduction Workflows





Face Detection and Facial Expression Analysis



- Fast detection of face, eyes, nose and mouth
- Emotion recognition happy

sad angry

surprised

- Gender classification
- Blink detection



X-ray Technology

Specialized Uses of X-ray Computed Tomography

- Inspection of solder joints in a Ball Grid Array Package
- Non-destructive testing of new materials for the aerospace industry
- Food-inspection, e. g. checking for glass fragments

X-ray image of solder joints in a Ball Grid Array Package







X-ray Technology

Imaging of Insect Tracheae

Live Atlas moth pupa



Yellow: respiratory tract (image generated from CT volume data)

Blue: digestive tract



Radio Frequency Technology



RF testing Antenna design and measurement, electromagnetic field simulation

RFID

Theft protection, access control, billing, road tolling, freight and container tracking

 RFID tags on und in metal Counterfeit protection



Navigation and Localization Technologies



- SatNav Receiver Technologies for GPS, GLONASS, GALILEO
- Localization in WLAN-, DECT- and Sensor Networks
- High resolution Microwave Localization System
- Inertial Sensoric to support and improve Navigation Systems (e.g. count steps, navigation of autonomous vehicles or robots)



Medical Communication and Sensor Systems



- ZigBee wireless connectivity for a combined ECG/SpO₂ sensor
- Transmission and visualization of data relating to heart rate, oxygen saturation, pulse wave and three ECG leads
- All electronic components are integrated on one ECG electrode, with two additional electrodes and the SpO₂ sensor connected by cable.



Medical Image Processing



- Development of image analysis methods to assist physicians in diagnosis, computer-aided cancer screening, sample collection and therapy monitoring
- Examples

computer-aided blood count analysis, computer-aided cervical smear analysis, 3D reconstruction of endoscopic images



Integrated Circuit Design

- Design of complex digital circuits
- RF circuits
- Mixed-signal ICs
- Analog-to-digital converters
- IC design support
- Solutions and services for small and medium-sized companies





CMOS as mainstream technology basis:

- Digital designs in production down to 90 nm
- Mixed signal designs in production down to 130 nm
- 90 nm mixed signal ASIC projects in development phase
- 65 nm analog in research phase
- Foundries: austriamicrosystems, Chartered, Fujitsu, Infineon, Micronas, ST, TI, Toshiba, TSMC, UMC, XFAB

SiGe and III-V for professional applications:

- 350 nm and 180 nm SiGe (up to 200 GHz $\rm f_T)$
- GaAs MESFET, HEMT and HBT experience since 1987
- Foundries: austriamicrosystems, IHP, IAF, TriQuint, UMS



RFIC Design for Professional Applications

Broadband IQ-modulators in production:

- 200 MHz 400 MHz
 0.6 µm GaAs MESFET
- 200 MHz 8 GHz 0.25 μm GaAs HEMT
- 500 MHz 2 500 MHz 0.8 μm SiGE

Under development:

- 500 MHz – 22 GHz 0.25 μm SiGe





Fluxgate Magnetometer Front-End ASIC

- 3 magnetic and 1 housekeeping ch
- Measurement channels with 19 bit resolution
- High sensitivity up to 10 pT
- Design and layout optimized for high radiation tolerance
 - Functional up to 260 krad total ionizing dose, single event latch up at 14.1 MeVcm²mg⁻¹





IC Design

Imager Design

Technologies:

CMOS 350 nm, 180 nm, 90nm

Targets :

- Optimized architectures
- Digital preprocessing
- ADC on imager
- Fast data acquisition and transfer
- Development of 2 Mpixel @ 1000 frames/sec





IC Design

Optical Nanostructures

- Implementation in standard CMOS
- Structuring of metal planes
- Various functionality including:
 - Colour filters, spectrometers with arbitrary filter functions
 - Polarization filters and cameras
 - Image sensors with inherent contrast enhancement for automotive safety-critical applications





Integrated Sensors (e.g. 3D-Hallsensors)



Why Hall-Sensors?

- Standard CMOS compatible
- No magnetic materials in sensor
 - -> very linear, no hysteresis,

high dynamic range

B _x	$\frac{\partial B_x}{\partial x}$	$\frac{\partial B_x}{\partial y}$
B_y	$\frac{\partial B_{y}}{\partial x}$	$\frac{\partial B_y}{\partial y}$
B_z	$\frac{\partial B_z}{\partial x}$	$\frac{\partial B_z}{\partial y}$

Main focus at Fraunhofer IIS

- Optimized lateral Hall-sensors
- Unique technology for vertical Hall Sensors
 - (patented; Trademark HallinOne pending)





3D Magnetic Field Sensing in Washing Machines

- A sensor determines the exact position of the drum, making it possible for manufacturers to use larger drums. As a result, more clothes can be washed using the same amount of energy.
- Application

Logixx series of washing machines made by Bosch-Siemens-Hausgeräte





High-Speed Optical Data Transmission

- Optical Data transmission, predominantly over short distances, using plastic or multimode glass fiber
- Design of optical sensors and sensor systems, light detection and measurement



RD-IDs for Wireless Sensor Networks in Logistics



From waybills to smart objects

 Tracking of goods throughout the manufacturing process and supply chain (when – where – what – in what condition)

Further applications

- Traceability of turbine parts in aircraft maintenance
- Planning school bus routes that accommodate different school start times and provide opportunities to change buses



Design Automation Division EAS, Dresden

 Development of methods and tools for computer-aided design of electronic circuits and systems

 Main areas of work Modeling, simulation, synthesis, optimization, verification and testing



Cooperations

- Integrated Circuits Design
- Integrated Circuits Production for Academic and Industrial
- Research on Microsystems, Sensors and Applications
- Sensor Networks for medical and environmental applications
- Digital Audio and Video Broadcasting systems
- Logistics and Navigation Systems
- Optics and Photonics



Cooperations

- R&D Cooperations and Contracts
- Proposals for FP7 EU-Projects
- Scientists and Students Exchange
- Internship program open for students all over the world



Thank you for your attention!

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