Brandenburg University of Technology Cottbus - Senftenberg

Fraunhofer IPMS

Prof. Harald Schenk | October 10th, 2023

Microelectronics and microsensor research at Brandenburg University of Technology Cottbus-Senftenberg (BTU C-S)

Agenda

I. Importance of microelectronics and microsensorics

II. Activities at BTU C-S

- Overview
- Example projects
  - iCampµs
  - OASYS

III. Activities of non-university R&D partners (RTOs) in Cottbus

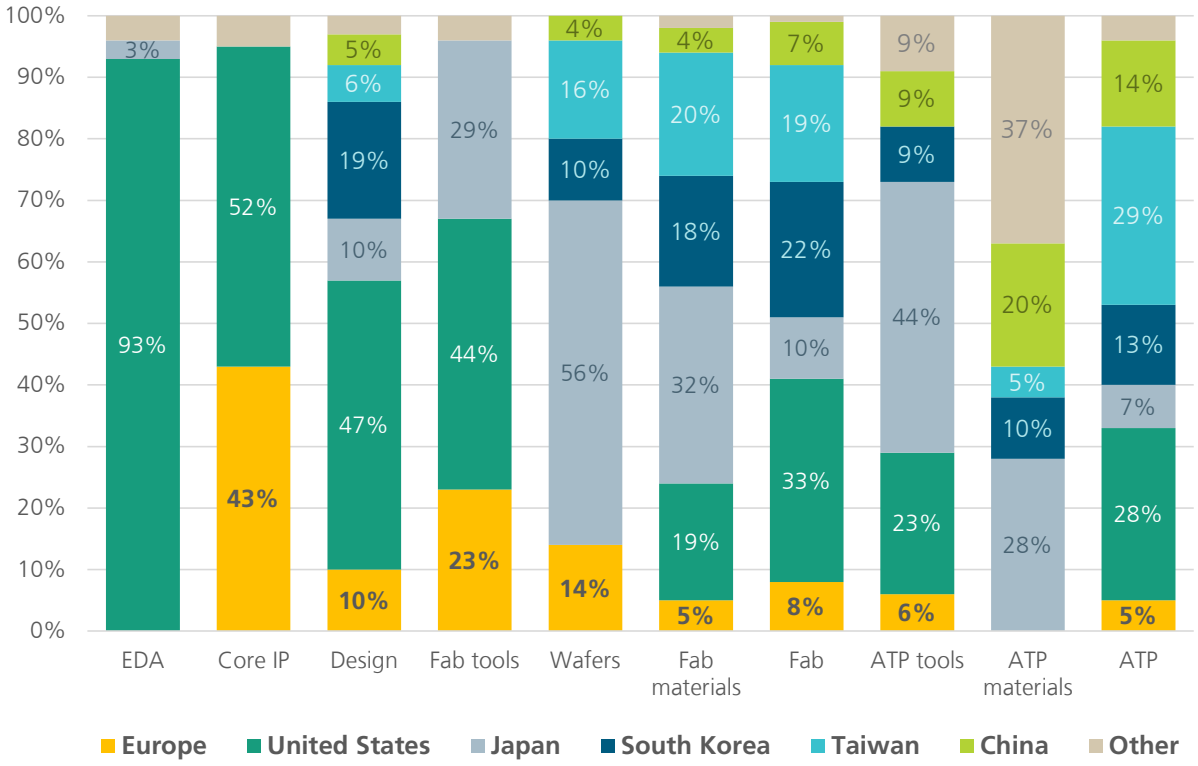
- Ferdinand-Braun-Institut fuer Hoechstfrequenztechnik (FBH)
- Leibniz Institute for High Performance Microelectronics (IHP)
- Fraunhofer IPMS
- Fraunhofer IZM
- Research Fab Microelectronics Germany (FMD)

Part I

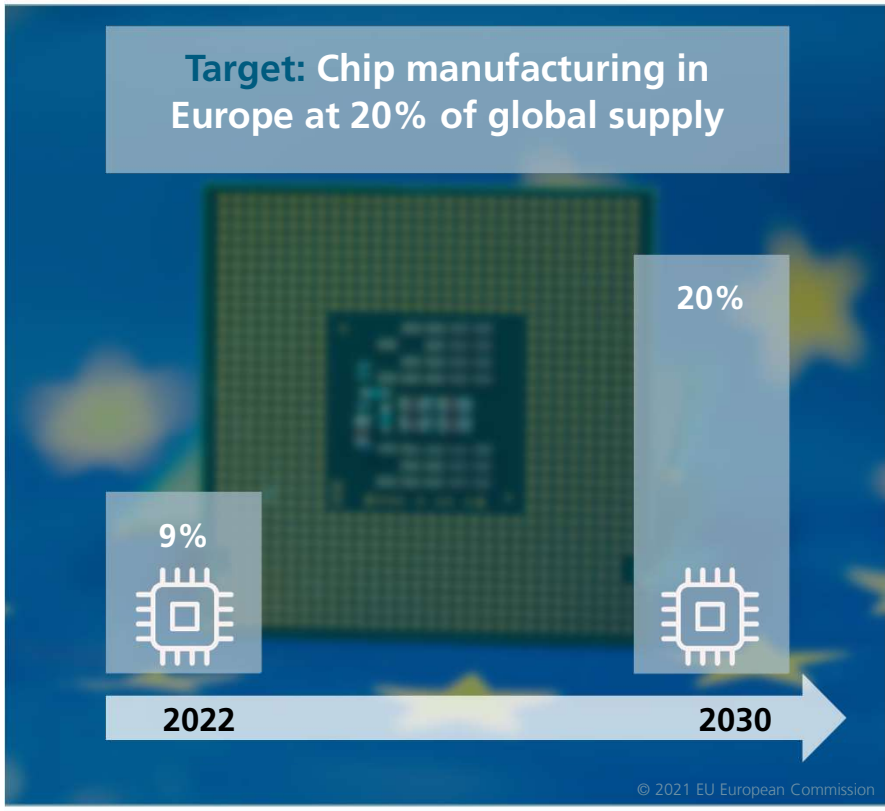
Importance of microelectronics and microsensorics

Microelectronics - enabler and driver of digitization

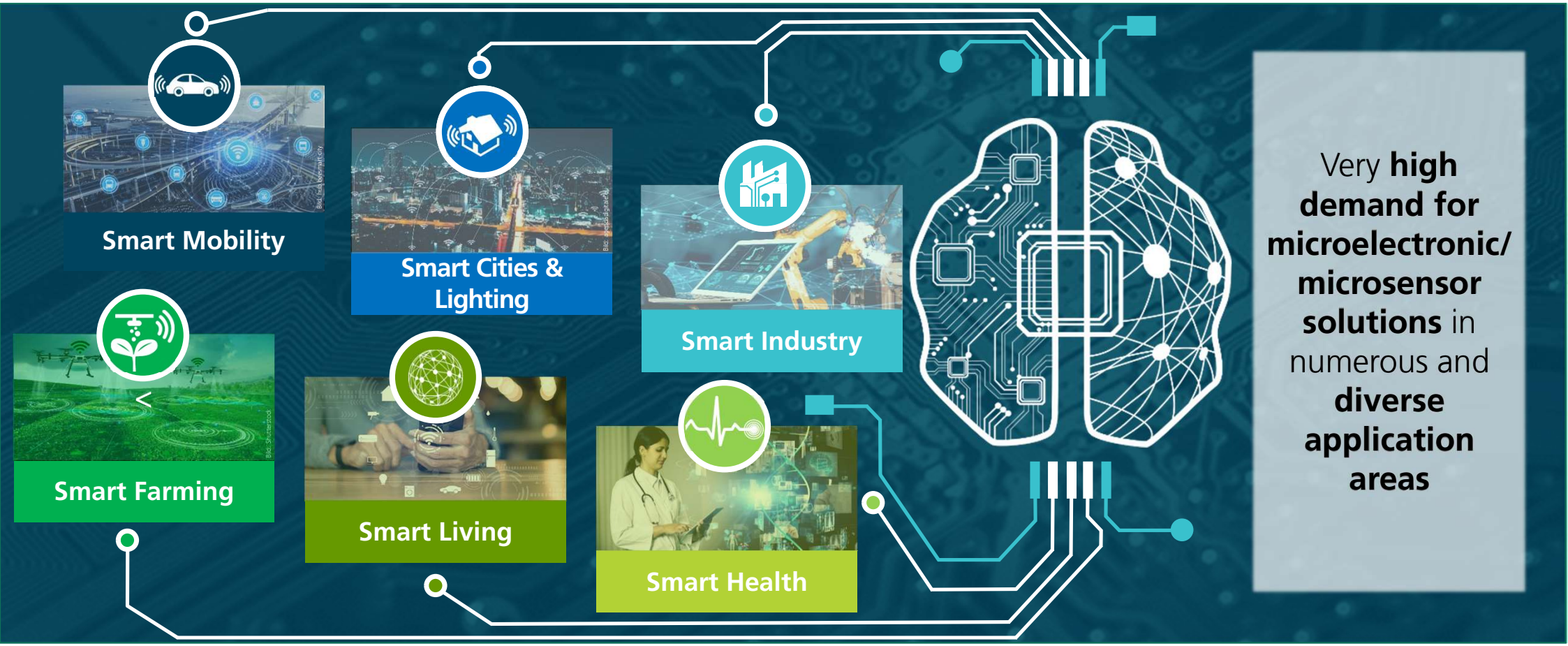
Europe's market share and ambition



Source: Kearney, 2021.
EDA = Electronic design automation, Core IP = Core intellectual property blocks; ATP = Assembly, testing, and packaging



Microelectronics - enabler and driver of digitization



Part II

Activities at BTU C-S

Microelectronics and Microsensorics at BTU C-S

Interdisciplinary research and development

Institute of Physics

Applied Physics and Semiconductor Spectroscopy *(Prof. Flege)*

Experimental Physics and Functional Materials *(Prof. Fischer)*

Semiconductor Materials *(Prof. Wenger)*

Micro and Nano Systems *(Prof. Schenk)*

Circuit Design *(Prof. Weger)*

Computational Physics (Prof. Seibold)

Institute of Computer Science

Computer Engineering *(Substitute Prof. Reichenbach)*

Wireless Systems *(Prof. Langendörfer)*

Distributed Measurement Systems and Sensor Networks *(N.N. – ongoing appointment process: in review phase)*

Institute of Electrical Engineering and Information Science

Electronic Systems and Sensors *(Prof. Gardill)*

Microelectronics *(Prof. Killat)*

Semiconductor Techn. *(Prof. Kahmen)*

Antennas and High-Frequency System Integration *(Prof. Ndip)*

Radio Frequency and Microwave Techniques *(Prof. Rudolph)*

Institute of Digital Production Quality and Logistics

Automation Technology *(Prof. Berger)*

= ***joint appointment*** *of BTU C-S and respective RTO*

Microelectronics and Microsensorics at BTU C-S

Subject areas and bundling of competencies

Sensor systems
Research into intelligent, networked sensory systems and development of required innovative, miniaturized components

Microwave & Terahertz
Research of cutting-edge devices and circuits for frequencies up to THz range

MEMS actuators
Research into actuator principles for micro- and nanomechanical systems, miniaturization and increasing the energy efficiency of components used

Beyond CMOS
Increasing the Performance and Functionality of SiGe BiCMOS Circuits

New materials
Development of new materials for innovative components and heterogeneous material systems for analog, digital, neuromorphic, quantum mechanical and optical signal and data processing

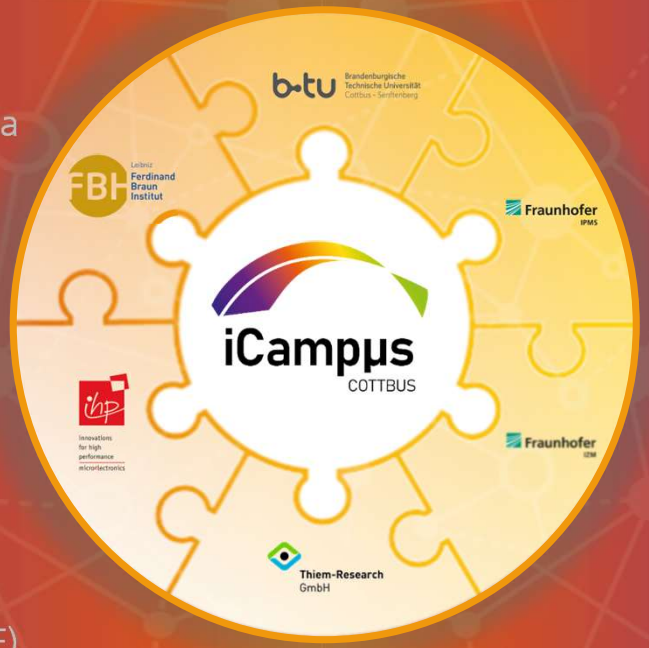
Optoelectronic systems
Research into fully integrated optoelectronic systems for image generation and image processing, as well as communication at Tbit/s speed

iCampµs Cottbus

Innovation Campus Electronics and Microsensors Cottbus – iCampµs

Research cooperation within the framework of the Federal Government for structural change in the coalmining region of Lusatia

Purpose:	R&D and transfer in the field of sensor technologies
Phase I:	11/2019 – 12/2021 5 consortium partners Volume: 7,5 M€
Phase II:	01/2022 – 12/2026 6 consortium partners *(**new:** Thiem-Research GmbH)* Volume: 20 M€
Funding:	Federal Ministry of Education and Research (BMBF)



Associated partners:

ABB · BEUTLHAUSER · BOSCH · dropnostix · IBAR · LAUSITZER WASSER LWG · Perinet · SENTECH · SILICON radar · thingk.systems

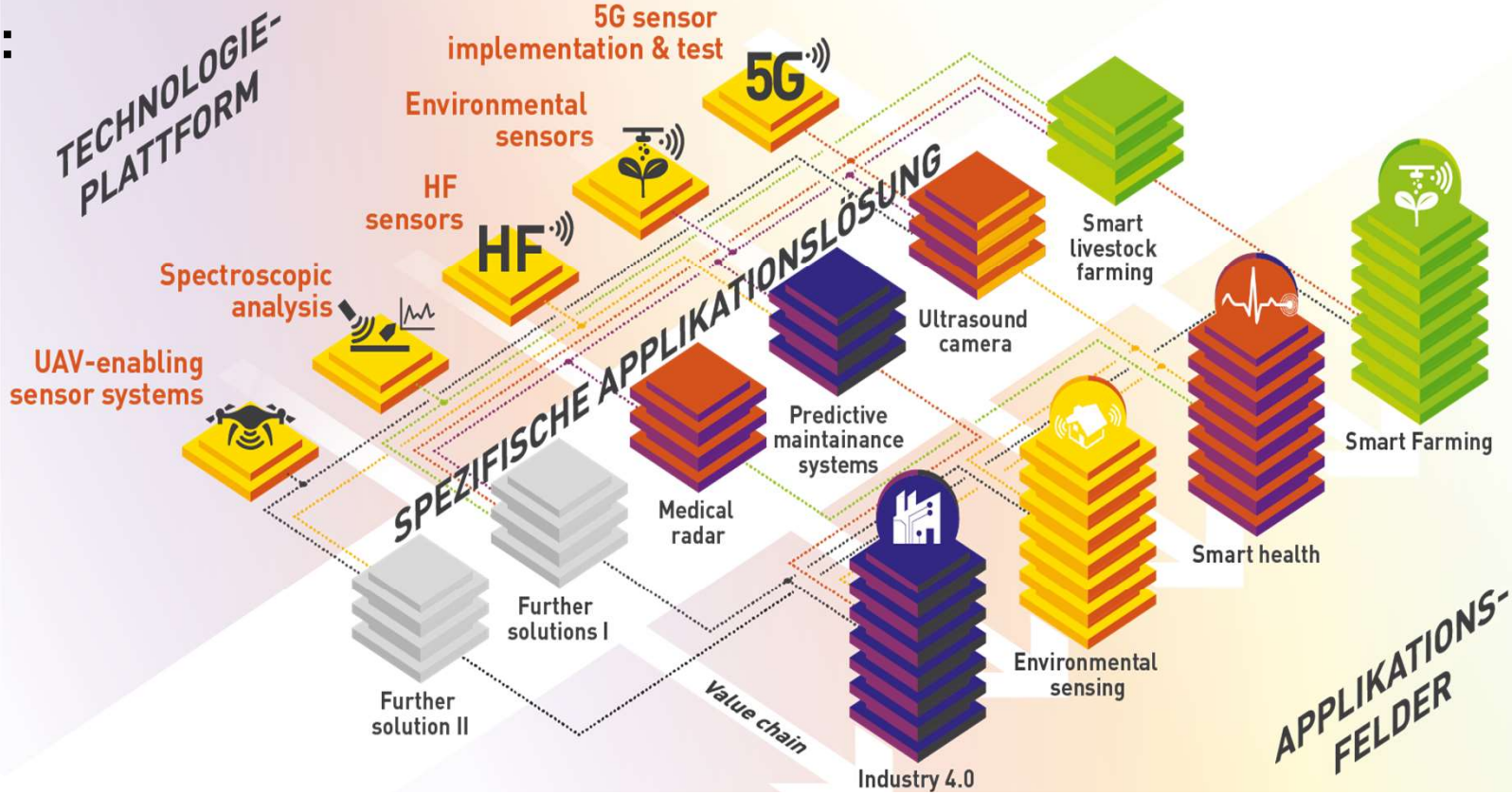
iCampµs Cottbus – Phase II

Technology platforms and special solutions

Phase II (2022-2026):

In the project,

- 5 technology platforms and
- 4 specific application solutions are developed,
- which address 4 application fields



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iCampµs Cottbus

iCCC2024 – iCampus-Cottbus Conference

www.iCCC2024.de

Topics:

- Actuators
- Condition monitoring
- Energy Management
- Health
- HF-MEMS
- Communication
- Lab on Chip
- Material & Process Technologies
- Mobility
- Environmental Sensors
- Economy & Sustainability

Extended Deadline for Abstracts:
November, 15th 2023

Notification of authors:
December, 1st 2023

Deadline for manuscripts:
January, 31st 2024

The iCCC2024 is an event of the BMBF funded structural change project iCampµs Cottbus www.iCampus-Cottbus.de.
It is organized by the Innovation Team and supported by AMA GmbH.

OASYS

Structure – Duration – Partner

OASYS –
Optosensors for **A**dvanced **Sys**tems in Life Science and Smart Production

Duration: 09/2023-09/2027 | Volume: ~ 12,5 M€
Funding: Federal Ministry of Education and Research (BMBF)

2 CLUSTERs with a total of five lead projects

MEMS-based hyperspectral imaging for smart applications — **A**

A1 **A2** **A3**

High-resolution optical methods for life science — **B**

B1 **B2**

Consortium partners:

btu Brandenburg University of Technology Cottbus - Senftenberg

Leibniz Ferdinand Braun Institut (FBH)

Fraunhofer IPMS

ihp

Practice partners:

ATB

AKmira optronics

cubert REAL-TIME SPECTRAL IMAGING

Carl-Thiem-Klinikum Cottbus

EKFZ Digital Health

photonic insights

Der Gesundheits-Campus

Knackig Sachsen

Landesverband „Sächsisches Obst" e.V.

SOLARVIBES

iTheraMedical

STORZ KARL STORZ – ENDOSKOPE

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OASYS

Lead projects

A » CLUSTER A » MEMS-based hyperspectral imaging for smart applications«

A1 Ultra compact intelligent hyperspectral camera

Hyperspektrale Bildgebung am Beispiel eines Apfels

b-tu Brandenburg University of Technology Cottbus - Senftenberg

Fraunhofer IPMS

A2 Imaging Spectrometer-Free Hyperspectral Raman Sensing

b-tu Brandenburg University of Technology Cottbus - Senftenberg

FBH Ferdinand Braun Institut

A3 Si-compatible detectors for object identification applications

b-tu Brandenburg University of Technology Cottbus - Senftenberg

ihp

Fraunhofer IPMS

B » CLUSTER B » High-resolution optical methods for life science«

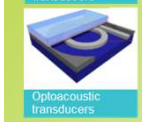
B1 MEMS-based imaging in & through scattering media

Mikrospiegel (Spatial Light Modulator)

b-tu Brandenburg University of Technology Cottbus - Senftenberg

Fraunhofer IPMS

B2 Optoacoustic sensor technology



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Part III

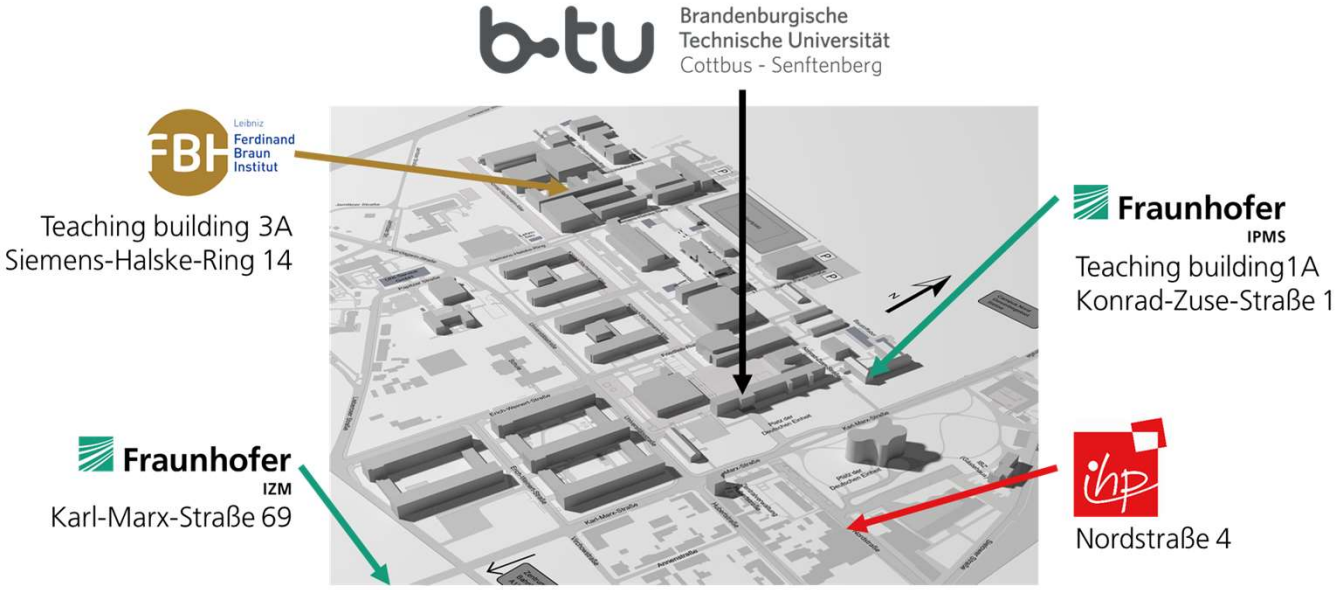
Activities of non-university R&D partners (RTOs) in Cottbus

Cooperation with non-university research institutions

Microelectronics-RTO (Research and Technology Organisation) at BTU Cottbus-Senftenberg

Extensive cooperation:

1. **Joint appointments**
2. Operation of **Joint Labs** and Fraunhofer **project groups**
3. Joint **R&D consortium projects**
4. RTO **presence on campus** with own institute or teaching building



Map of the central campus of BTU Cottbus-Senftenberg including the location of the non-university research institutions.

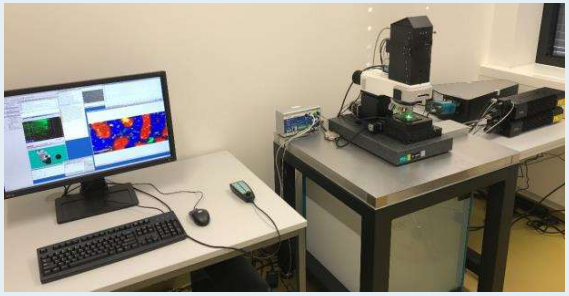
Ferdinand-Braun-Institut fuer Hoechstfrequenztechnik (FBH)

Raman Analytic for life sciences at Cottbus

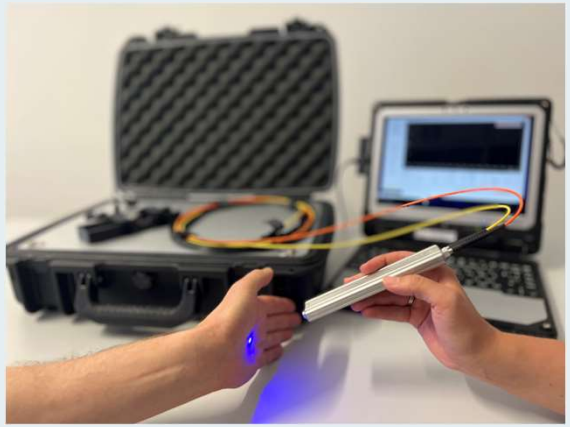
Competences and Research Foci

- **Application lab:** Raman-microscope for spatially resolved measurements
- **Raman measurement systems for the medical applications**
  - Spectrometer based system with an excitation wavelength at 488 nm.
  - Spectrometer free system with an excitation wavelength at 450 nm
- **Customized light sources and turnkey systems**
- **Systems ethics approved for clinical study** together with Thiem-Research and Carl-Thiem-Clinical-Center
- **Raman measurement systems for various applications, e.g. agriculture:**

  Spectrometer based system with an excitation wavelength near 785 nm
- Cooperation with BTU Cottbus towards the application of **artificial intelligence for data analysis**

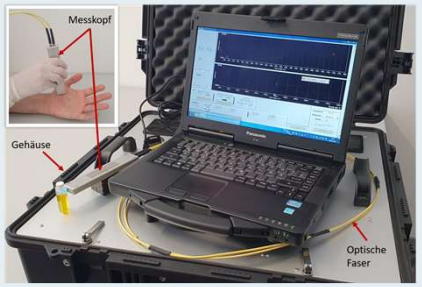


Cottbus Application Lab



Application Example: Medical Health

Raman Measurement System



Application Example: Agriculture

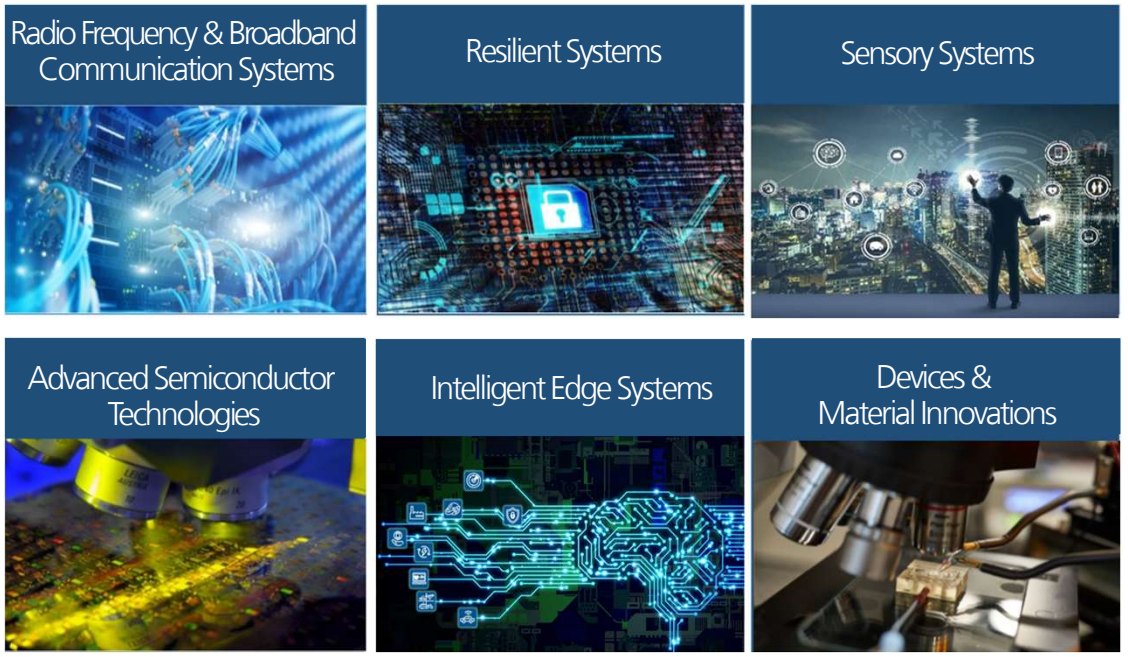
Leibniz Institute for High Performance Microelectronics (IHP)

Competence Center for Silicon-Germanium Technologies and Systems

R&D Services

- Qualified end-to-end SiGe BiCMOS Technologies for prototyping and small scale manufacturing
- MPW service for prototyping
- Technology development service for dedicated process steps
- RF and digital Circuit Design and IP development
- Low volume Analog, Digital- and Mixed-Signal Chip production test
- Semiconductor material analysis and failure mode analysis & diagnostics
- RF characterization and measurement support up to 500 GHz

Application-specific research and development in the following **research fields**:



Fraunhofer Institute for Photonic Microsystems IPMS

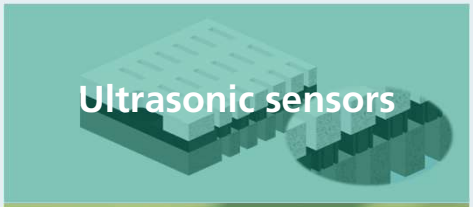
Branch Integrated Silicon Systems ISS

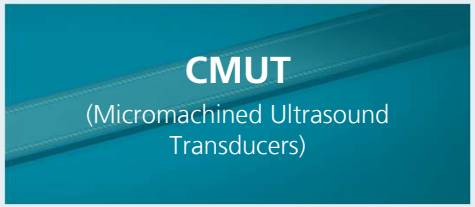
State-of-the-art research on semiconductor based photonic, electrochemical and acoustic applications

R&D Services on 200 mm and 300 mm

- **Detection** and **intelligent processing** of measured variables from miniaturized sensors and systems
- Determination of **material states** and **relevant attributes** for
  - industrial processes,
  - biological-medical diagnostics and analytics
  - and other customer specific applications
- Development of **customer-specific components, modules** and **entire systems**
- Competencies in hardware-related software development for **sensor signal processing**

Technologies: Sensors and Actuators





Fraunhofer Institute for Reliability and Microintegration IZM

Branch Lab for High-Frequency Sensors & High-Speed Systems

Innovative RF packaging solutions, components & modules for sensing, communication & computing

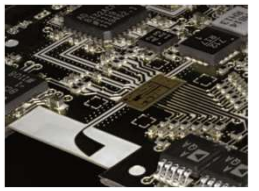
Research Fields

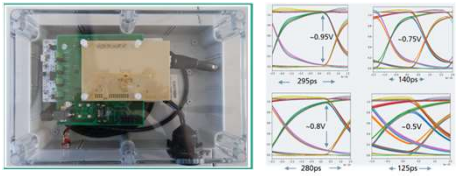
Application-specific research and development in the following fields:

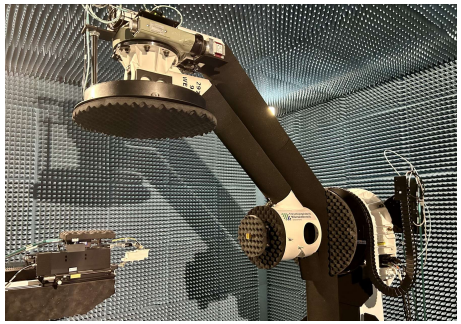
- **Radar & proximity sensors** for
  - Medical & healthcare
  - Industrial automation
  - Safety & security
  - Smart farming
- **High-speed wireless communication** modules of end devices and systems (5G, 6G)
- **High performance computing (HPC)** modules

R&D Services

- **Investigation of suitable RF packaging technologies** for development of radar & proximity sensors, wireless communication and HPC modules
- **RF design, layout and measurement-based characterization** (up to 300 GHz) of the following:
  - RF front-end modules for radar sensors & communication systems (e.g. for 5G, 6G)
  - Proximity sensors (e.g. inductive sensors)
  - Antennas and passive components
  - RF packages & platforms (e.g. SiP, AiP)
- **Signal & power integrity driven design, layout and test** of high-speed interposers & boards for HPC

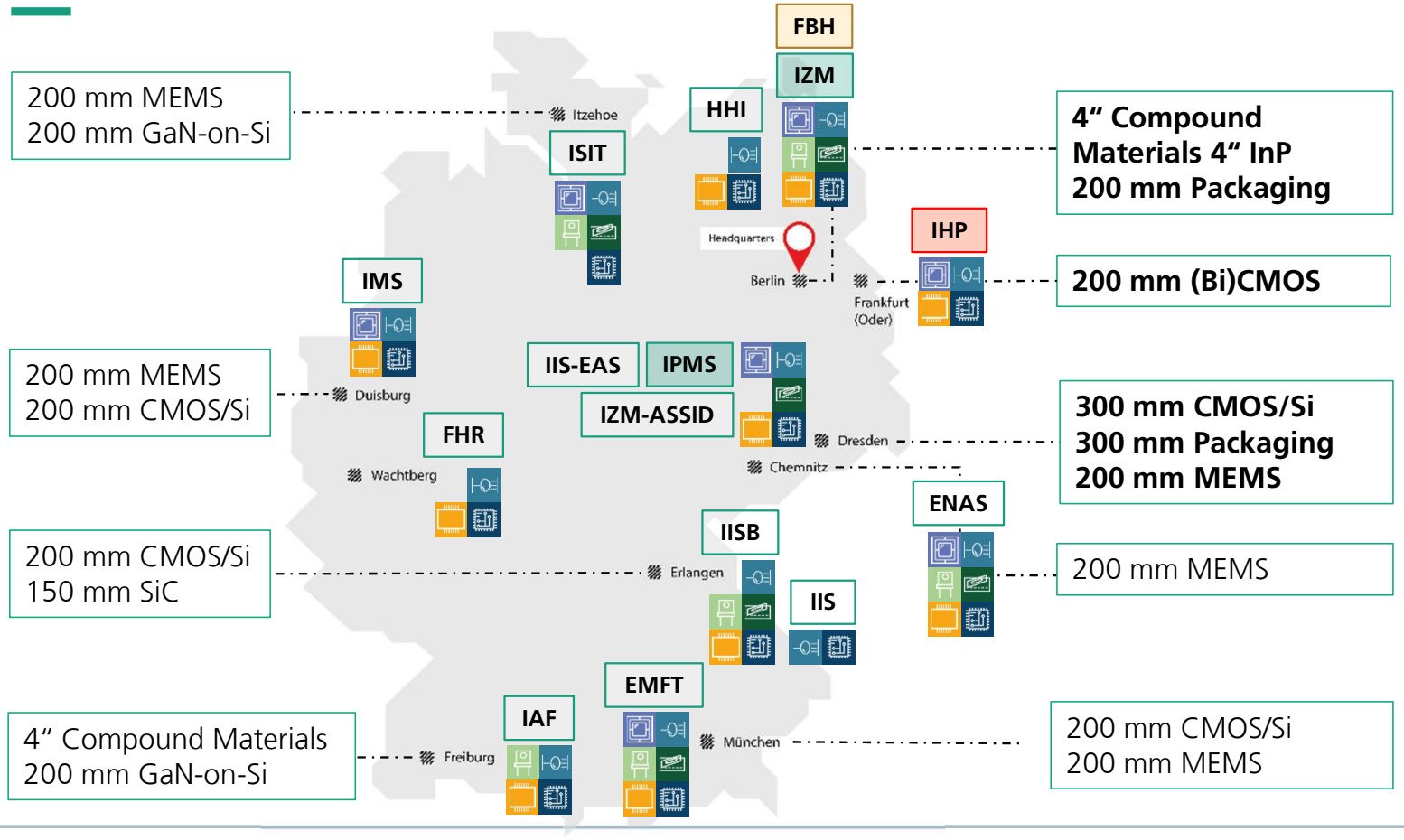






Research Fab Microelectronics Germany (FMD)

Clean rooms and technology platforms (Germany-wide)



FMD Technology platforms

- Extended CMOS
- Optoelectronic systems
- Power Electronics
- MEMS Actuators
- Microwave & Terahertz
- Sensor systems

Forschungsfabrik Mikroelektronik Deutschland

Research Fab Microelectronics Germany (FMD)

One-Stop-Shop

As a **One-Stop-Shop**, FMD offers industry and science **customized technology and system developments** along the entire value chain **from a single source**.

*A **single institute** with specific know-how and excellent individual competencies.*

*A strong cooperation of **13 institutes** with know-how and infrastructure bundled in a One-Stop-Shop*

FMD consolidates microelectronics research spread across eleven Fraunhofer and two Leibniz institutes (FBH, IHP) in Germany

- **Cross-technology** and **cross-institutional R&D concepts** for optimal collaboration with industry
- **Customized technology and system developments**
- Joint laboratories and joint production facilities
- Organization of combined prototype and pilot production
- **Industrial contract research,** support for innovators and start-up activities
- Technology and knowledge transfer

Profile of FMD as RTO:

- **Applied research** with a solid foundation in academic research and strong ties to industry
- Focus on **heterogeneous system integration (AHSI)** in good synergy (with imec / leti) at EU level.
- FMD drives research on the integration of heterogeneous systems at EU level

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Thank you very much for your attention!