

# Mikroelektronische Schaltungen und Systeme

## Introduction

Prof. Dr.-Ing. Ahmet Cagri Ulusoy

Institut für Hochfrequenztechnik und Elektronik (IHE)

Prof. Dr.-Ing. Dr. h. c. Jürgen Becker

Institut für Technik der Informationsverarbeitung (ITIV)



- 1. Team and Institute (IHE)**
- 2. Team and Institute (ITIV)**
- 3. ITIV**
- 4. Lecture Organization**
- 5. Exam**
- 6. Ilias Course**



# Team (IHE)

# TEAM (IHE)

## ■ Lecturer

- Prof. Dr.-Ing. Ahmet Cagri Ulusoy
  - Email: [cagri.ulusoy@kit.edu](mailto:cagri.ulusoy@kit.edu)
  - Room: IHE
  - Consultation hours: by arrangement



## ■ Advisor Exercises

- M. Sc. Ahmed Aksu
  - Email: [ahmed.aksu@kit.edu](mailto:ahmed.aksu@kit.edu)
  - Room: Gebäude 30.34 Raum 011
  - Consultation hours: by arrangement





# Institut für Hochfrequenztechnik und Elektronik (IHE)

# Institute of RF Engineering and Electronics

## Joint Directorate



Prof. Ulusoy



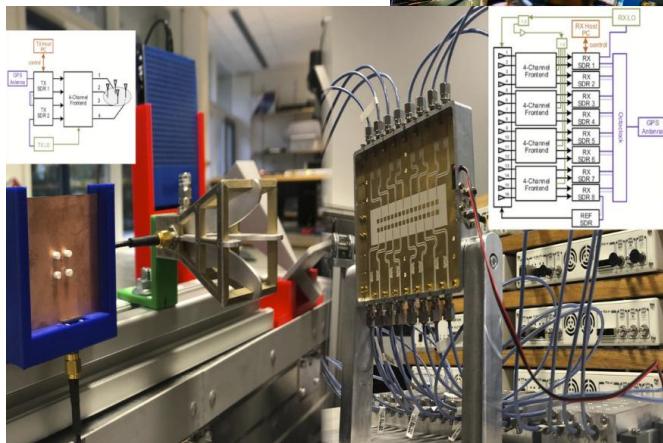
Prof. Zwick

## Research Pillars

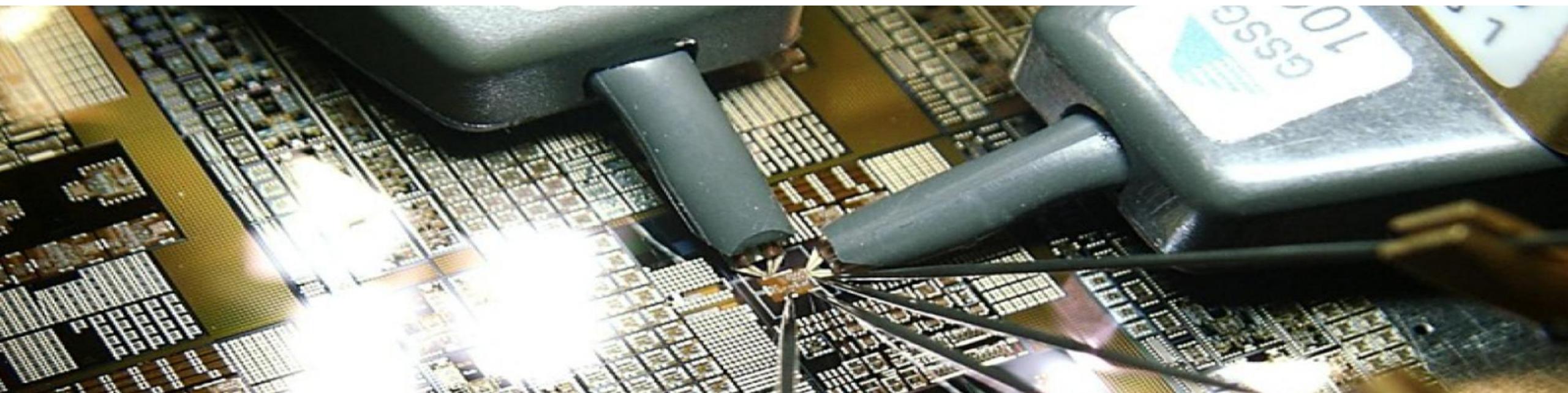
- IC Design
- Antennas and Millimeter-Wave Packaging
- Radar and Communications Technology



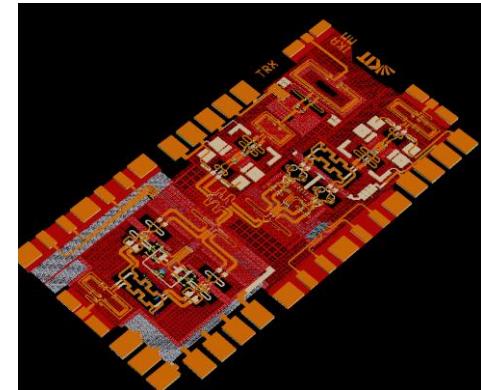
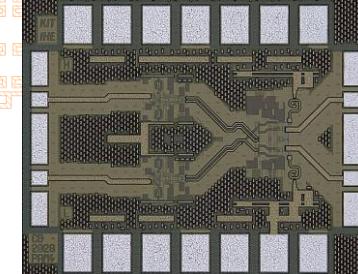
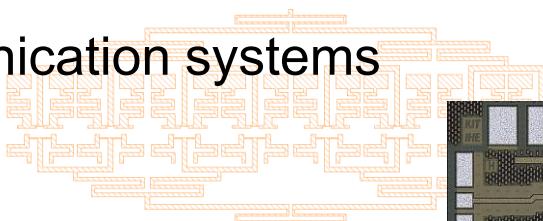
- IHE one of the 14 Institutes within the faculty of ETIT
- ETIT ~2000 (BSc + MSc) students
- 28 full-time PhD students + 1 Lecturer, 4 Postdocs
- 20-25 BSc/MSc Thesis / year
- **Chair of integrated high-speed circuits** established in 2019 (15 scientists)



# Research on High-Speed Integrated Circuits



- RF & millimeter-wave ICs, sensors & communication systems
- Broadband mixed-signal ICs & photonics
- Extreme environment electronics, modelling & reliability



# Research on High-Speed Integrated Circuits

PhD Training 4-5 Years

System  
Considerations  
Technology  
Investigation

IC Design &  
Verification

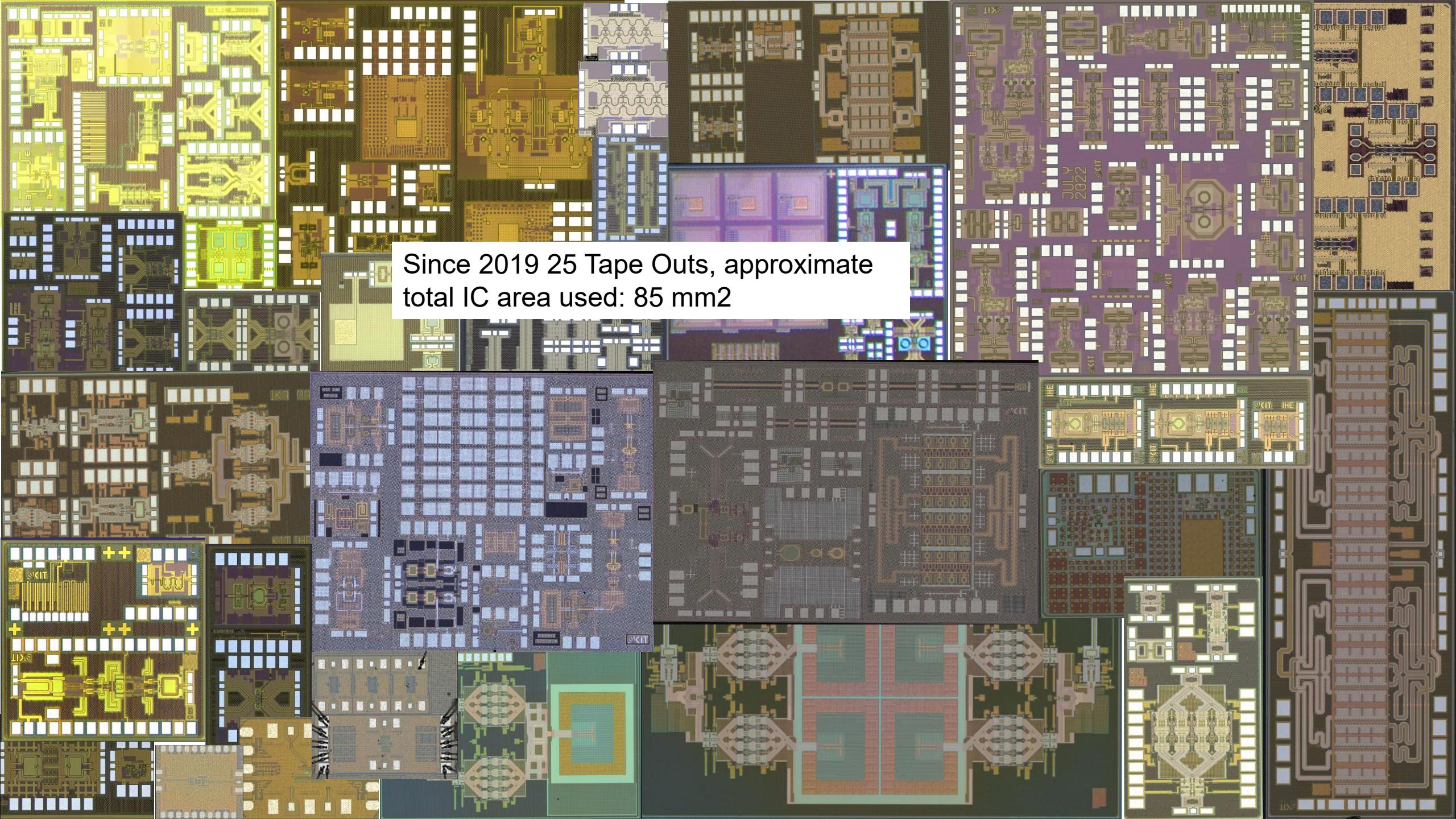
System /  
Subsystem  
Demonstration

- Technology Experience:
- IHP 0.13 µm SiGe BiCMOS
  - GF 22 nm FDX CMOS
  - Infineon B11/12 SiGe BiCMOS
  - ST 55 nm SiGe BiCMOS
  - III-V Labs InP HBT
  - GF 8HP/9HP, 130CBIC SiGe
  - TSMC 65 nm CMOS
  - Tower H3-H5 SiGe BiCMOS
  - Intel 16 nm FinFET
  - NXP SiGe BiCMOS
  - TI SiGe BiCMOS

Foundry Support: Europractice, IHP, ST, III-V Labs  
University Programmes: GlobalFoundries, Infineon

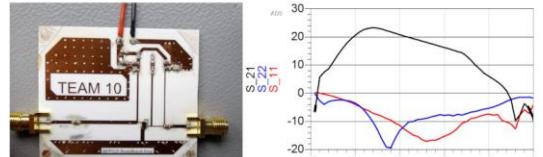
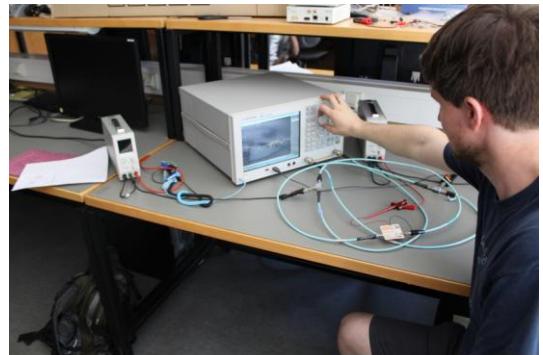
BSc / MSc Thesis, HiWis

**milli IC GmbH**  
mmWave ASIC Design Solutions

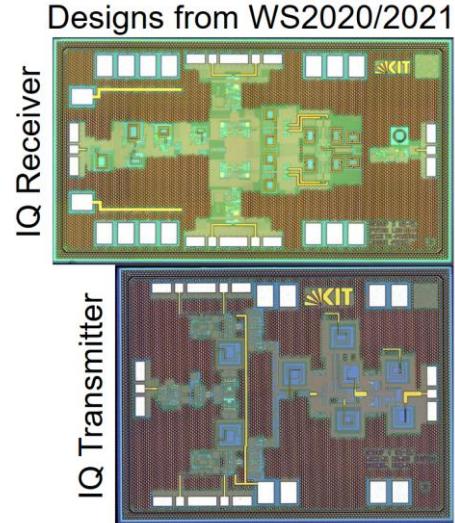


Since 2019 25 Tape Outs, approximate  
total IC area used: 85 mm<sup>2</sup>

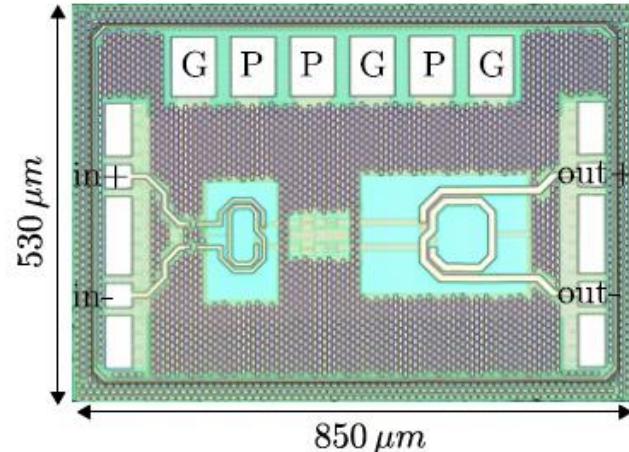
# Microelectronics, Photonics, and Quantum Technologies - Lab Courses



Practical Amplifier Design



MMIC Design Lab



A Differential Ka-Band PA with Transformer Matching in 250 nm SiGe BiCMOS

Benjamin Sandrock<sup>#1</sup>, Kaan Balaban<sup>\$2</sup>, Ahmet Cagri Ulusoy<sup>\$3</sup>,

<sup>#</sup>Robert Bosch GmbH, Germany

<sup>\$</sup>Karlsruhe Institut für Technologie (KIT), Germany

<sup>1</sup>benjamin.sandrock@de.bosch.com, <sup>2</sup>kaan.balaban, <sup>3</sup>ulusoy)@kit.edu



Best MSc & BSc  
Thesis awards

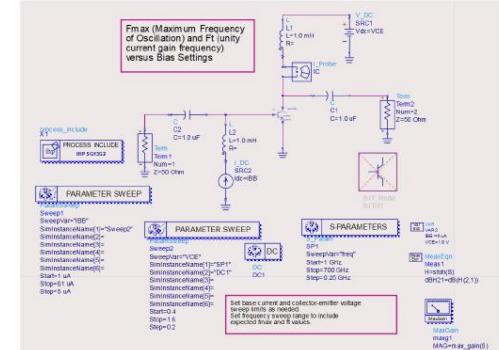
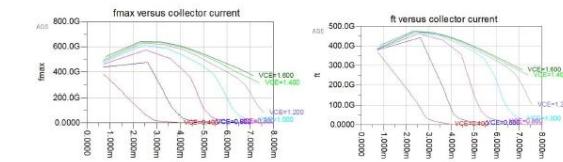


Figure 2: BJT  $f_t$ ,  $F_{max}$  vs. Bias with IHP Process Setup



RFIC design lecture & workshop

RFICS

# Team (ITIV)

# TEAM (ITIV)

## ■ Lecturer

- Prof. Dr.-Ing. Dr. h. c. Jürgen Becker
  - Email: becker@kit.edu
  - Room: 324
  - Consultation hours: by arrangement



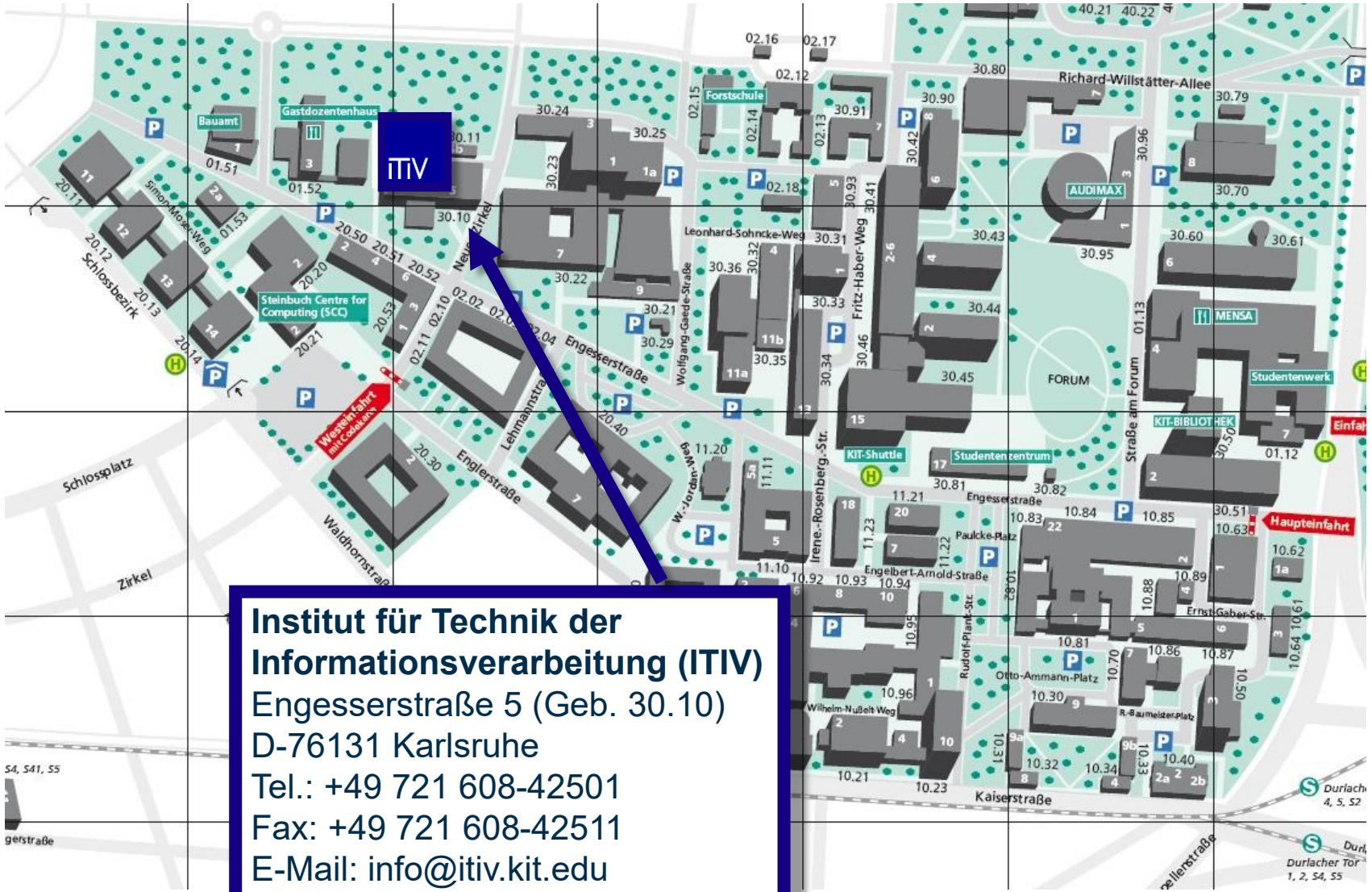
## ■ Advisor Exercises

- M. Sc. Henrik Scheidt
  - Email: henrik.scheidt@kit.edu
  - Room: 125.1
  - Consultation hours: by arrangement



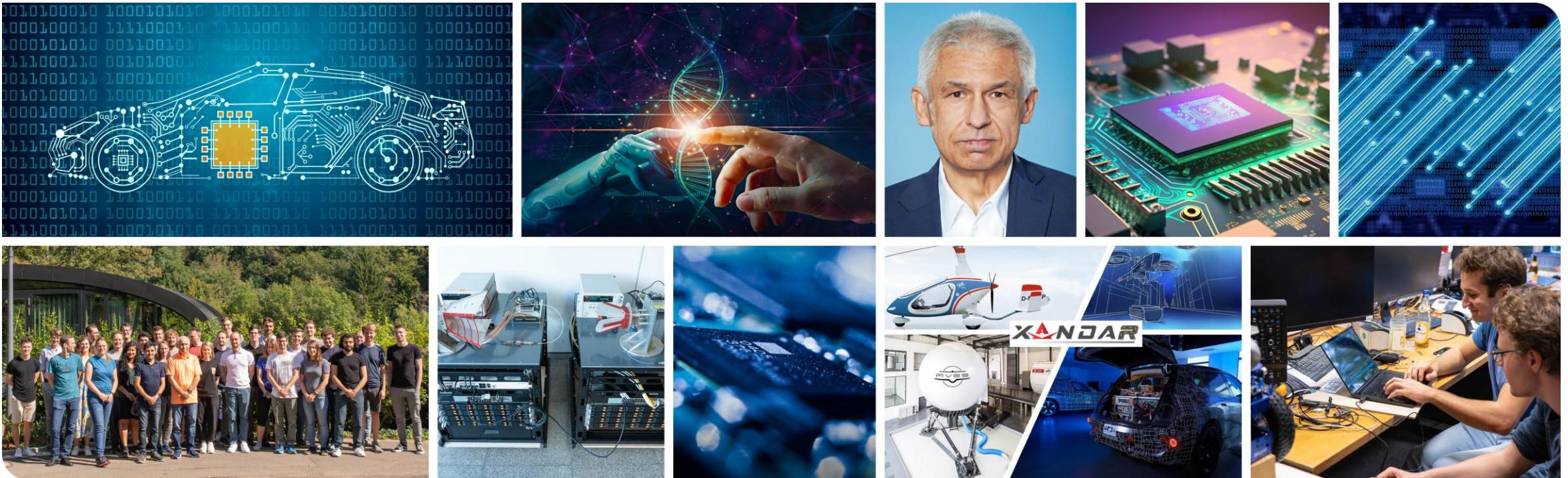


# Institut für Technik der Informationsverarbeitung [vconf.wb.wtvp.kit.edu](http://vconf.wb.wtvp.kit.edu) (ITIV)

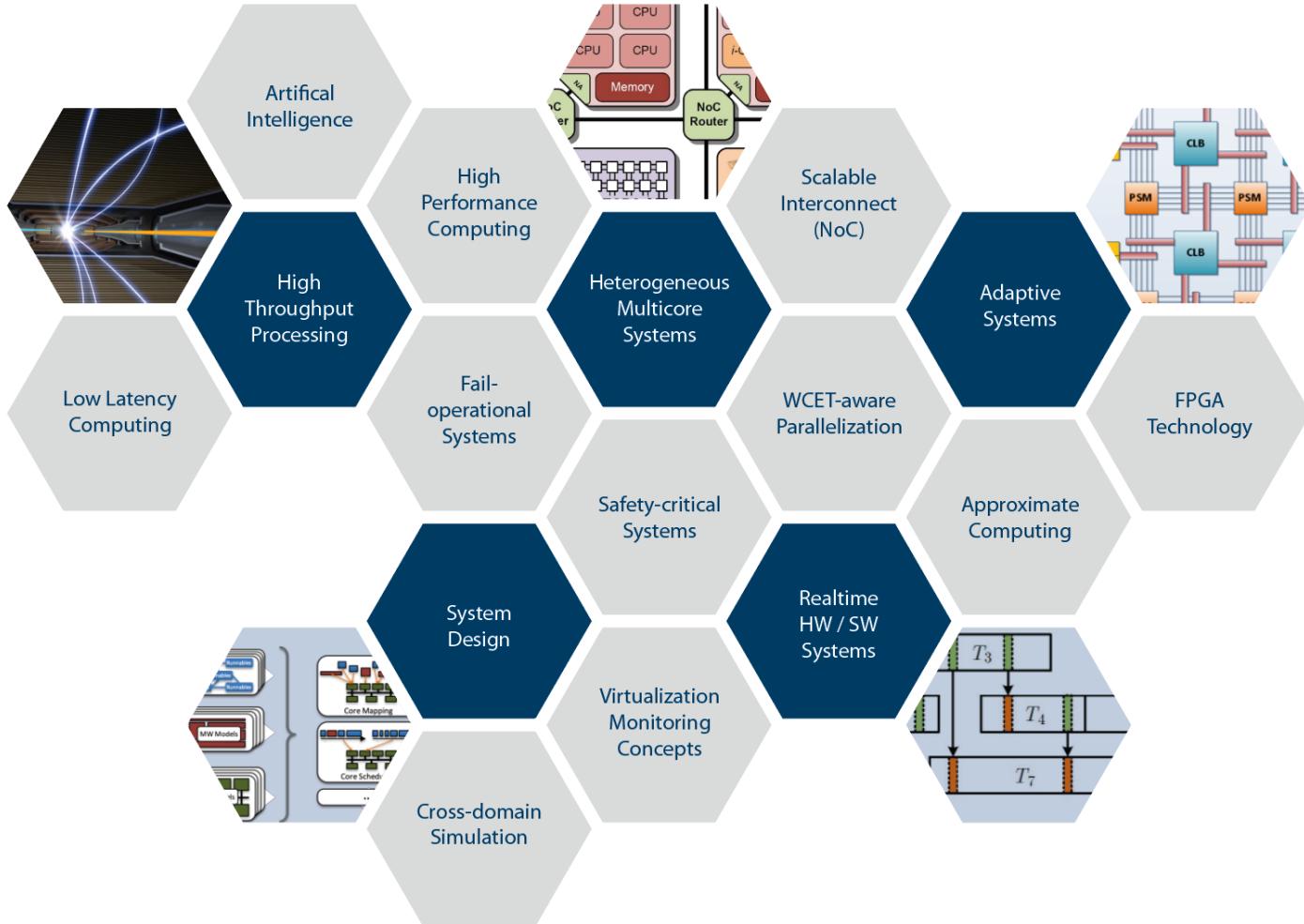


# AG „Eingebettete elektronische Systeme“

- Leiter: Prof. Dr.-Ing. Dr. h. c. Jürgen Becker

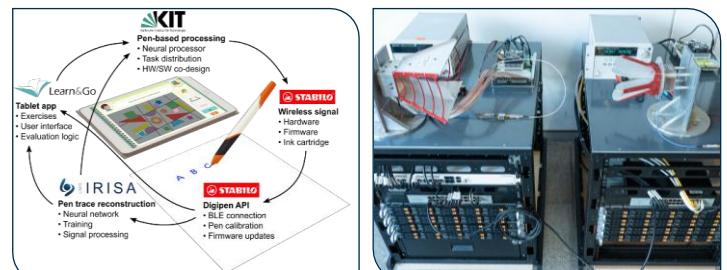


# AG „Eingebettete elektronische Systeme“



XANDAR

CeCas



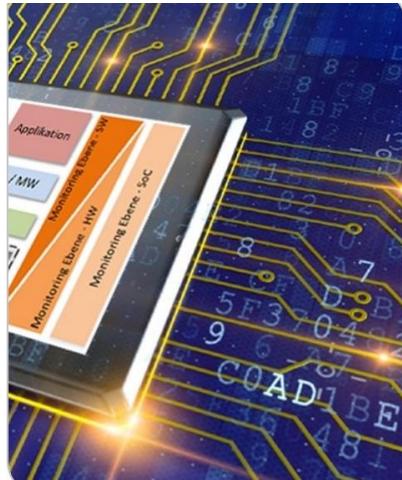
KIHT

Open6GHub



# AG „Eingebettete elektronische Systeme“

- Prof. Dr.-Ing. Dr. h. c. Jürgen Becker
  - Institutsleiter seit 2001
  - 30 Doktoranden
  - 41 abgeschlossene Promotionen
  - 18 laufende Projekte
  - mehr als 400 Publikationen
  - 14 Lehrveranstaltungen, u. a.
    - Digitaltechnik
    - Communication Systems and Protocols
    - Praktikum Entwurf digitaler Systeme



# Forschungsthemen von Prof. Becker

- System-on-Chip (SoC), Network-on-Chip (NoC)
- Hardware Software Codesign
- Multi-Core-Prozessor-Architekturen
- HPC- & KI-basierte Systemintegration
  - Spezifische Beschleuniger
  - Zuverlässigkeit, Echtzeit und Leistung
- Dynamisch rekonfigurierbare Systeme
- Hardware-Synthesemethoden und Mehrdomänen-Modellierungs- und Simulationstechniken
- Cyber-Physical Systems (CPS)





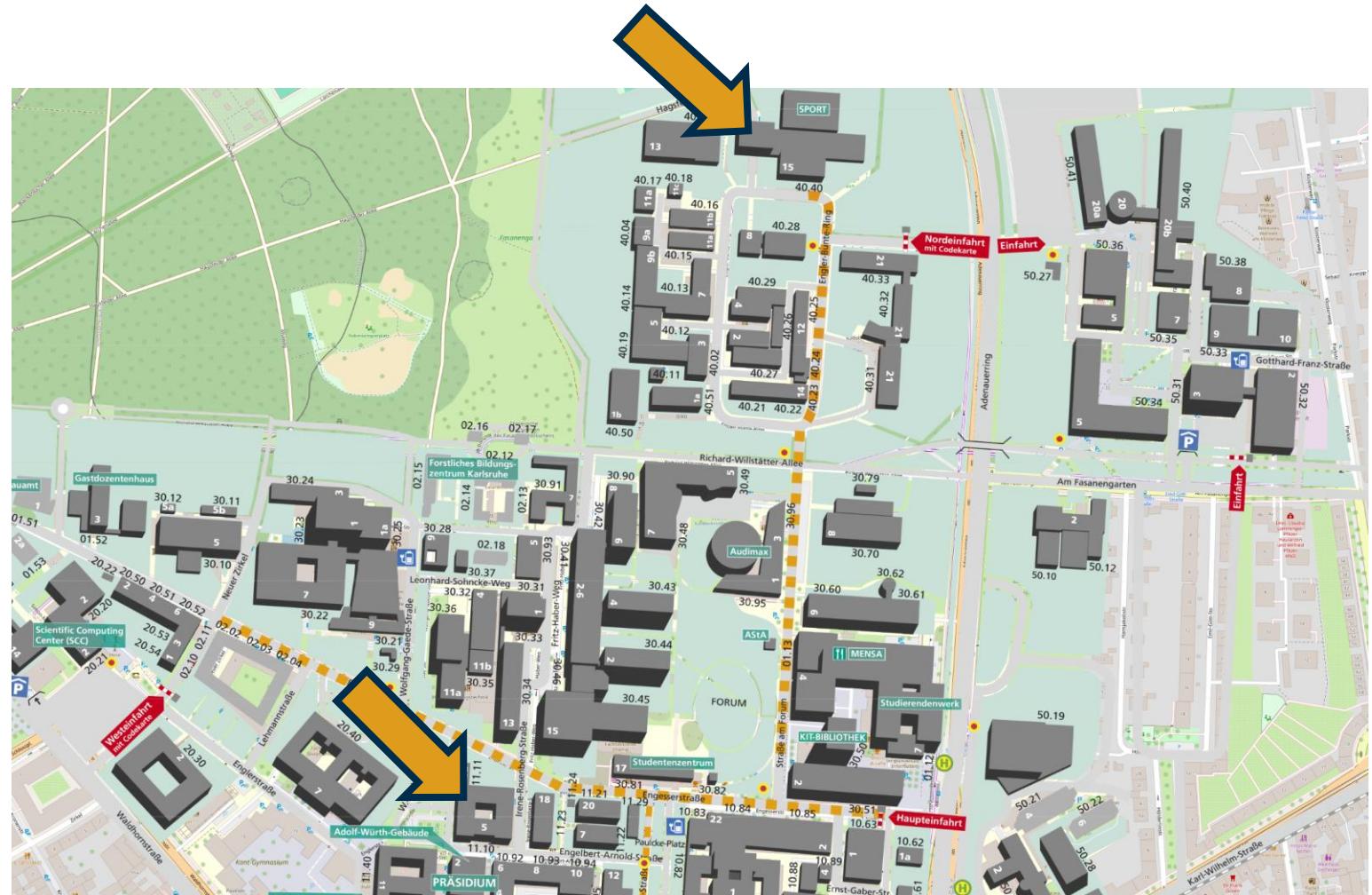
# Lecture Organisation

# Lecture Organisation

- The Lecture is equally divided into:
  - Analog Part (IHE)
  - Digital Part (ITIV)
- Note
  - **The lecture is new with new content.** Therefore, no exact timetable can be given.
  - The Plan:
    - In the WS 25/26 **30 time slots** are given:
      - ~12 lectures + 3 exercises (IHE Prof. Ulusoy)
      - ~12 lectures + 3 exercises (ITIV Prof. Becker)
      - 1 Q&A appointment

# Lecture Organisation

- Lecture and Exercise will take time and place at:
  - **Wednesday** 11.30-13.00 o'clock at 40.40 Sport-Hörsaal (R007)
  - **Friday** 8.00 – 9.30 o'clock at 11.10 Engelbert-Arnold-Hörsaal (EAS)



# Exam

# Exam WS 25/26

- Form: Written Examination
- Language: German
- Date: 27.02.2025
- Time: 17:30 – 19:30
- Location: 30.95 Audimax
- Allowed Aid: 1 Formulary Sheet DIN A4 (both sides printed/written on)
- Structure:
  - 50/50 distribution between tasks from the IHE and the ITIV.



# Ilias Course

# Ilias Corse

- Link: [https://ilias.studium.kit.edu/goto.php?target=crs\\_2747889](https://ilias.studium.kit.edu/goto.php?target=crs_2747889)
- Content:
  - Lecture Slides
  - Exercise Slides
  - Exam Infos
  - Forum for Questions
  - Forum for Announcements

# Content

# Mikroelektronische Schaltungen und Systeme



# Mikroelektronische Schaltungen und Systeme

Lect.17 Technology Mapping	Lect.18 FPGA	Lect.19 Physical Design I	Lect.20 Physical Design II	Lect.21 Q&A	Lect.1 Intro/CMOS Basics	Lect.2 Single Stage Amplifiers	Lect.3 Noise	Lect.4 Differential Amplifiers	Lect.5 Current Mirrors	Lect.6 Frequency Response	Lect.7 Feedback	Lect.8 Operational Amplifiers	Lect.9 Stability and Frequency Compensation
Lect.15 Digital Building Blocks	Lect.16 Memory	Lect.14 Timing of Sequential Circuits	Lect.13 Sequential Circuits	Lect.12 Combinational Logic Circuits	Lect.11 Introduction to Data Converters	Lect.10 Switched-Capacitor Circuits							
28	29/10/25	 	Mikroelektronische Schaltungen und Systeme										

# Literature

# Literature

## Analog Part

- [1] Razavi, B. (2016). **Design of analog CMOS integrated circuits (Second edition).** McGraw-Hill Education.
- [2] Sedra, Adel S., Smith, Kenneth C.. (2016). Microelectronic Circuits (Ed. 7th). United States of America: Oxford University Press
- [3] Baker, R. J. (2019). CMOS: Circuit design, layout, and simulation (4th ed.). Wiley-IEEE Press.

## Digital Part

- [1] S. L. Harris and D. M. Harris, *Digital design and computer architecture*, ARM® edition. Waltham, MA: Morgan Kaufmann, 2016. <https://dl.acm.org/doi/10.5555/2815529> (free eVersion)
- [2] H. M. Lipp and J. Becker, *Grundlagen der Digitaltechnik*, 7., verb. Aufl. München: Oldenbourg, 2011. <https://www.degruyter.com/document/doi/10.1524/9783486706932> (free eVersion)
- [3] N. A. Sherwani, *Algorithms for VLSI Physical Design Automation*. Boston, MA: Springer US, 1993. doi: 10.1007/978-1-4757-2219-2.
- [4] B. T. Preas, B. D. Ackland, and M. J. Lorenzetti, Eds., *Physical design automation of VLSI systems*. Menlo Park, California: The Benjamin/Cummings Publishing Company, 1988.

