# 2023 IEEE Radio & Wireless Week

## *Final Program*

**Las Vegas, NV, USA** · 22-25 January, 2023 · Planet Hollywood Hotel


RWW · RWS · SiRF · WiSNet · PWR · SHaRC

**2023 Radio & Wireless Week Sponsors**

IEEE Microwave Theory and Techniques Society (MTT-S)

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IEEE Antennas and Propagation Society (APS)
IEEE Geosciences and Remote Sensing Society (GRSS)

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**www.radiowirelessweek.org**

## GREETINGS FROM GENERAL CHAIR OF RADIO & WIRELESS WEEK 2023

General Chair
Alexander Koelpin

Welcome to the 18th IEEE Radio & Wireless Week (RWW), welcome to Las Vegas, Nevada! Directly located at the famous Las Vegas Boulevard at Planet Hollywood Hotel our conference will be stimulated from the international flair, the curiosity to learn new things, and experiencing exciting events together of this worldwide famous resort city.

Over the years, RWW has become a staple in the scientific year of many in the wireless and microwave community. From January 22 to January 25, 2023, it's that time again and researchers from all over the world discuss the latest trends in their scientific areas of expertise in five co-located conferences on the complementary and mutually beneficial topics summarized in the Topical Meeting on Silicon Monolithic Integrated Circuits in RF Systems (SiRF), the IEEE Topical Conference on Power Amplifiers for Wireless and Radio Applications (PAWR), IEEE Topical Conference on Wireless Sensors and Sensor Networks (WiSNet), IEEE Space Hardware and Radio Conference (SHaRC), and Radio and Wireless Symposium (RWS). This construct of complementary sub-conferences covers all relevant and modern areas of radio technology, from theory to components and systems, from kilohertz to terahertz, from communication to sensing and space applications. Integrated circuit technology is as well represented as system level investigations or AI based impairments compensation.

In well-established RWW tradition, scientific findings will be presented in topically clustered oral talks and during interactive poster sessions. Each co-located conference has its focus days: PAWR will be held Monday, SiRF on Monday and Tuesday, WiSNet and SHaRC on Wednesday framed with at least one full track of RWS sessions Monday, Tuesday, and Wednesday. This core technical program is supplemented by four workshops on RF and mmW Devices, Circuits and Systems for Low Earth Orbit Satellite Missions, Radar-based Vital Sign Sensing – the Latest Trends, Health Aspects of Millimeter-Wave Radiations in 5G and Beyond, and a special radar boot camp on D-Band FMCW Radar – Basics and Signal Processing for PhD students and young professionals. For young professionals, in addition, a dedicated hands on workshop on artificial intelligence for wireless communications will be given to allow our young talents to get an insight is this important topic also for the microwave community. Learning new aspects is also the goal of the two short courses on Linearization of Power Amplifiers used in Radio Frequency (RF) Transmitters and PA Characterization/Automation for DPD Metrics and Algorithm Validations.

The new class of MTT-S Distinguished Microwave Lecturers will present their talks during a dedicated track on Monday, which is a perfect opportunity to get a comprehensive overview over interesting topics that may be slightly off the own focus. The new tradition in a panel session of female role models in our community is this time again organized by the Women in Microwave team. Two top-class invited keynote speakers will give an insight in their work during the opening ceremony and plenary session on Tuesday morning, where also the winners of the student paper competition will be awarded. In this paper competition, students evaluated best by the reviewers during paper submission are allowed to present their topic in an "elevator pitch" setting before answering detailed questions of the judges at their posters. The best presented and scientifically most convincing student paper will win the competition.

We are very happy that again for RWW2023 the Automatic Radio Frequency Techniques Group (ARFTG) will co-located their conference, which is the 100th edition of this very successful interest group meeting on RF and microwave test and measurement. Congratulations, dear colleagues, on this success! Besides the ARFTG conference with technical papers and short courses, a joint ARFTG & RWW exhibition will be hosted to give industry the opportunity to present their latest products and sophisticated solution to the community.

As always, the exhibition floor will be the place where networking is in focus, which is also underlined by the industry reception hosted on Monday. Directly after the reception, a joint ARFTG & RWW panel will discuss the topic "The road to D band is full of good intentions" with experts from semiconductor industry and measurement technology enterprises followed by the ARFTG dinner. A second panel session on Beamforming Solutions for Terrestrial and Space Applications will be held on Tuesday evening accompanied by the Space Night event.

Another highlight is the co-located IoT summit, one more of the very successful collaborations of RWW with other interest groups. The 6th IEEE Internet of Things (IoT) Vertical and Topical Summit will focus on Quantum Information Technologies for IoT. As always, IoT summit will be highly interactive with strong involvement of the audience in panel discussions after each session.

A lot of ideas, heart and soul, and time went into organizing RWW2023. This would not have been possible without the tremendous work of the beautiful Steering Committee team. Thank you for all for efforts and volunteering time! Now, it's time to enjoy the result.

Welcome to RWW! Enjoy the conference, meet experts and friends!

Alexander Koelpin, *Hamburg University of Technology*
**RWW 2023 General Chair**

## RWW 2023 STEERING COMMITTEE

General Co-Chair
Changzhi Li

Technical Program Chair
Holger Maune

**General Chair:**
Alexander Koelpin, *Hamburg University of Technology*

**General Co-Chair:**
Changzhi Li, *Texas Tech University*

**Technical Program Chair:**
Holger Maune, *Otto-von-Guericke-Universität Magdeburg*

**Finance Chair:**
Václav Valenta, *European Space Agency*

**Topical Conferences:**

**PAWR Co-Chairs:**
Roberto Quaglia, *Cardiff University*
Vittorio Camarchia, *Politecnico di Torino*

**WiSNet Co-Chairs:**
Rahul Khanna, *Intel*
Paolo Mezzanotte, *University of Perugia*

**SHaRC Co-Chairs:**
Markus Gardill, *Brandenburg University of Technology*
Marie Piasecki, *NASA Glenn Research Center*

**SiRF Chair:**
Roee Ben-Yishay, *Mobileye, An Intel Company*

**Distinguished Microwave Lecturers Chair:**
Markus Gardill, *Brandenburg University of Technology*

**Workshops Chairs:**
Venkata Vanukuru, *GlobalFoundries*
Jan Budroweit, *German Space Agency*

**Technical Lectures:**
Juan A. Becerra, *Universidad de Sevilla*

**IoT Summit Liaison:**
Charlie Jackson, *Northrop Grumman*
Jasmin Grosinger, *Graz University of Technology*

**Women in Engineering Chair:**
Jasmin Grossinger, *Graz University of Technology*

**Student Paper Contest Co-Chairs:**
Fabian Lurz, *Hamburg University of Technology*
Ken Kolodziej, *MIT Lincoln Laboratory*

**University Demo Chair:**
Mario Pauli, *Karlsruhe Institute of Technology*

**Young Professionals Chair:**
Pushkar Bajirao Kulkarni, *Qualcomm*

**Publicity & Publications Co-Chairs:**
Glauco Fontgalland, *Universidade Federal de Campina Grande*
Roberto Gomez-Garcia, *University of Alcala*
Gregor Lasser, *Chalmers University*

**Microwave Magazine Special Issue Editor:**
Markus Gardill, *Brandenburg University of Technology*

**MTT Transactions Mini Special Issue Editors:**
Holger Maune, *Otto-von-Guericke-Universität Magdeburg*

**Exhibition/Sponsorships Chair:**
Cassandra Carollo, *IEEE MCE*

**RWW Executive Committee Chair:**
Robert Caverly, *Villanova University*

**Conference Management:**
Elsie Vega, *IEEE MCE*
Cassandra Carollo, *IEEE MCE*

**Visa Letters:**
Cassandra Carollo, *IEEE MCE*

**Webmasters:**
Min Hua, *Raysilica*
Joel Arzola, *Raytheon Technologies*

**At Large (Advisors):**
Kevin Chuang, *Analog Devices*
Nuno Borges Carvalho, *Universidade de Aveiro*
Rashaunda Henderson, *University of Texas at Dallas*

## RWS 2023 TECHNICAL PROGRAM COMMITTEE

**High-speed and Broadband Wireless Technologies:**
Upkar Dhaliwal, Masaaki Kojima, Muh-Dey Wei, Kevin Chuang, Jennifer Kitchen, Jing Wang, Dietmar Kissinger

**Emerging Wireless Technologies & Novel Engineered Materials:**
Hyun Kyu Chung, Ahmad Hoorfar, Syed Abdullah Nauroze, Junyu Shen, Alessandro Cidronali, Sangkil Kim, Spyridon Pavlidis, Hjalti Sigmarsson

**Wireless System Architecture and Propagation Channel Modeling:**
Juan Antonio Becerra, Aly Fathy, Maria J. Madero-Ayora, Pravin Premakanthan, Ugo Dias, Paulo Ferreira, Chenming Zhou

**Wireless Digital Signal Processing and Artificial Intelligence:**
Nuno Carvalho, Rui Ma, Arnaldo Oliveira, Pushkar Kulkarni, Markus Gardill, Eiji Okamoto, Ken Kolodziej

**Applications to Bio-Medical, Environmental, and Internet of Things:**
Chia-Chan Chang, Syed Islam, Chau Yuen, Daniel Rodriguez, Robert Caverly, Mohammad-Reza Tofighi, Changzhan Gu, Jenshan Lin

**Antenna Technologies, MIMO and Multi-Antenna Communications:**
Wasif Khan, Jiang Zhu, Rashaunda Henderson, Edward Niehenke, Dariush Mirshekar, You Zou, Jeremy Muldavin

**Passive Components & Packaging:**
Roberto Gomez-Garcia, Dimitra Psychogiou, Li Yang, Bayaner Arigong, T.-S. Jason Horng, Yu-Chen Wu, Jong Gwan Yook, Sai-Wa Wong

**MM-Wave to THz Systems & Applications:**
Shanthi Bhagavatheeswaran, David Delrio, Glauco Fontgalland, Renato Negra, Sergio Pacheco, Xinwei Wang, Yi-Jan (Emery) Chen, Nathalie Deltimple, Minoru Fujishima, Hiroshi Okazaki, Xin Wang, Yu Ye

## SIRF2023 DESCRIPTION

**SiRF2023** will mark the 23rd topical meeting on SiRF, with a renewed emphasis on promoting a dialogue between IC designers and researchers promoting non-standard technologies, exploiting the maturity of Silicon processes, but addressing the challenges of tomorrow. The three days of SiRF2023 will chronicle recent advances in our dynamic field, and provide the platform for developing new ideas, and candid exchange, facilitated by SiRF's single-session format. As in past years, a line-up of reputed invited speakers will stimulate our discussions, with an emphasis on emerging technologies.

## SIRF2023 STEERING COMMITTEE

**Conference Chair:**
**Roee Ben-Yishay,** *Mobileye, An Intel Company*

**Technical Program Chair:**
Robert Schmid, *Johns Hopkins Applied Physics Lab*

**Technical Program Co-Chair:**
**Mehmet Kaynak,** *IHP Microelectronics*

**Publicity Chair:**
**Ickhyun Song,** *Hanyang University*

**International Liaison - Asia:**
**Chien-Nan Kuo,** *National Chiao Tung University*

**International Liaison - Europe:**
Mehmet Kaynak, *IHP Microelectronics*

**Executive Committee:**
Yi-Jan Emery Chen, *National Taiwan University*
Julio Costa, *Qorvo*
Vadim Issakov, *University Magdeburg*
Mehmet Kaynak, *IHP Microelectronics*
Eric Kerherve, *University of Bordeaux*
Dietmar Kissinger, *Ulm University*
Chien-Nan Kuo, *National Chiao Tung University*
Hao Li, *Infineon Technologies*
Donald Lie, *Texas Tech University*
Venkata Koushik Malladi, *NXP Semiconductors*
Monte Miller, *NXP Semiconductors*
Sergio Pacheco, *NXP Semiconductors*
Nils Pohl, *Ruhr-Universität Bochum*
Jae-Sung Rieh, *Korea University*
Hasan Sharifi, *HRL Labs*
Ahmet Cagri Ulusoy, *Karlsruhe Institute of Technology*
Václav Valenta, *ESA/ESTEC*

## SIRF2023 TECHNICAL PROGRAM COMMITTEE

**RF, Millimeter-wave and THz Integrated Circuit Front Ends:**
Amit Jha, Ickhyun Song, Robert Schmid, Rahul Kodkani, Christopher Coen, Michael Oakley, Cagri Ulusoy, Roee Ben-Yishay, Austin Chen

**Wireline Communication Circuits and Silicon-Photonics Integrated Circuits:**
Saeed Zeinolabedinzadeh, Vadim Issakov, Ankur Guha Roy, Juergen Hasch, Aleksey Dyskin

**High Speed Data Converters & Mixed Signal Circuits:**
Wei-Min (Lance) Kuo, Monte Miller, Arindam Sanyal, Hsieh-Hung Hsieh, Chien-Nan Kuo

**Devices, Materials, Modeling, and Measurement:**
Mehmet Kaynak, Katsuyoshi Washio, Jean-Pierre Raskin, Venkata Malladi, Florian Herrault, Ming-Ta Yang, Julio Costa, Pierre Blondy, Vikas Shilimkar, Xun Gong

## GREETINGS FROM TPC CHAIR

TPC Chair
Holger Maune

Welcome to IEEE Radio & Wireless Week 2023 (RWW 2023), being held in downtown Las Vegas, at Planet Hollywood Resort & Casino. Each year, the ubiquity of wireless systems in our everyday lives grows through applications that range from safety and security to wearable medical devices. Many advances are being made through research and development in academia and new-product introduction in industry. The Covid-19 pandemic changed our lives and lead to an unforeseen additional increase in data rates. Two years ago, video conferences were used on few occasions. Today, video conferencing is part of everybody's life, from the kindergarten kid up to our senior citizens. The future will bring even more connectivity to our communities, and RWW is part of the development. RWW's technical program encompasses five conferences: the IEEE Radio and Wireless Symposium (RWS); IEEE Topical Meeting on Silicon Monolithic Integrated Circuits in RF Systems (SiRF); IEEE Topical Meeting on Power Amplifiers for Wireless and Radio Applications (PAWR); IEEE Topical Meeting on Wireless Sensors and Sensor Networks (WiSNet); and IEEE Space Hardware and Radio Conference (SHaRC). A total of 180 papers were submitted from 20 countries, of which 80 papers are written by students from around the globe. The TPC selected the most original and innovative papers, leading to an exceptional program for RWW 2023. The technical papers are scheduled from Monday to Wednesday as oral podium presentations or interactive poster presentations. Four workshops have been developed starting on Sunday and ending Monday afternoon with presentations by Distinguished Microwave Lecturers (DMLs) and other invited speakers who will share their knowledge on relevant topics in the wireless field.

The student paper competition continues to be an area of success for RWW, where judges select two student paper winners the Radio & Wireless Week. All student papers are reviewed in the same manner with identical criteria as regularly submitted manuscripts. The finalists will participate in a special event on Monday afternoon in addition to the regular presentation. The winners will be announced at the RWW plenary session on Tuesday.

The 101st ARFTG Microwave Measurement Conference will be co-located with RWW 2023. This time, Measurement Challenges for Emerging RF-to-THz Technologies are in the focus of the conference, which is taking place Monday and Tuesday. The conference is framed by the NIST-ARFTG Short Course on Microwave Measurements on Sunday and a workshop on Wednesday.

We hope the program convinces for a visit of IEEE Radio & Wireless Week 2023 in Las Vegas. For the latest updates on RWW 2023, visit www.radiowirelessweek.org.

Holger Maune
**TPC Chair**

# RWW TOPICAL CONFERENCES

## POWER AMPLIFIERS FOR RADIO AND WIRELESS APPLICATIONS (PAWR)

Power amplifiers are often the most critical component of RF/microwave communications systems and consequently the focus of intense research to achieve increased linearity and power efficiency. New forms of power amplification are being developed to meet the needs of the wireless communication equipment industry and the world's demand for greater information transmission. **PAWR2023** will feature tracks on RF/microwave Power Amplifiers. Papers featuring innovative work are solicited in (but not limited to) the following areas of RF/microwave power amplifier technology:

- High Power/Wideband Active Devices
- Power Amplifiers for Mobile, Avionics and Space
- Modeling and Characterization
- Advanced Circuit Design and Topologies
- Green Power Amplifier Technology
- Integration Technology
- Packaging and Reliability
- Linearization and Efficiency Enhancement Techniques
- Applications, Novel Architectures and System Analysis

**PAWR2023 Chair**
Roberto Quaglia, *Cardiff University*

**PAWR2023 Co-Chair**
Vittorio Camarchia, *Politecnico di Torino*

### PAWR2023 Technical Program Committee

**Modeling and Characterization:**

| | |
|---|---|
| Kefei Wu | David Runton |
| Filipe Barradas | Vittorio Camarchia |
| Stephen Maas | Jose Pedro |
| Zoya Popovic | Patrick Roblin |
| Ehsan Azad | |

**Advanced Circuit Design and Topologies:**

| | |
|---|---|
| Paolo de Falco | Jose A. Garcia |
| William Hallberg | Wolfgang Heinrich |
| Chao Lu | Frederick Raab |
| Paolo Colantonio | Nathalie Deltimple |
| Bumman Kim | Francesc Purroy |

**Packaging and Reliability:**

| | |
|---|---|
| Robert Caverly | Florinel Balteanu |
| Murat Eron | Ming Ji |
| Chang-Ho Lee | Don Lie |

**Linearization and Efficiency Enhancement Techniques:**

| | |
|---|---|
| Taylor Barton | Christian Fager |
| Juan A. Becerra | Wenhua Chen |
| Armando Cova | Pere Gilabert |
| Allen Katz | Anding Zhu |
| Morten Olavsbråten | Kevin Chuang |

## IEEE SPACE HARDWARE AND RADIO CONFERENCE (IEEE SHaRC)

The IEEE Space Hardware and Radio Conference (**IEEE SHaRC**) addresses new concepts, novel implementations, as well as emerging applications for space-based hardware for communications, earth observation, and other novel disruptive services. To meet recent needs, there has been a renaissance of interest and investment in space- and suborbital- based systems especially for high-data-rate communications networks. These new global satellite networks are disruptive, rely on new system and subsystem design paradigms, and are an enabler for many novel applications. The IEEE Space Hardware and Radio Conference provides a forum for discussions on this new frontier.

**SHaRC2023 Chair**
Markus Gardill, *Brandenburg University of Technology*

**SHaRC2023 Co-Chair**
Marie Piasecki, *NASA Glenn Research Center*

### SHARC2023 Technical Program Committee

**Systems, Hardware, and Electronics for Space:**

| | |
|---|---|
| Thomas Ussmueller | Nuno Carvalho |
| Jasmin Grosinger | Ramesh Gupta |
| James McSpadden | Steven Reising |
| Steven Rosenau | Rick Sturdivant |
| Vaclav Valenta | Robert Weigel |
| Markus Gardill | Federico Clazzer |

**Mission Concepts, Operations, Regulation, and Standardization:**

| | |
|---|---|
| Jan Budroweit | Goutam Chattopadhyay |
| Rudy Emrick | Dale Force |
| Charles Jackson | Holger Maune |
| Thomas Royster | Klaus Schilling |
| Zizung Yoon | Sachidananda Babu |
| Dustin Schroeder | Marwan Younis |

## WIRELESS SENSORS AND SENSOR NETWORKS (WiSNet)

Wireless sensors and wireless sensor networks are crucial components for manufacturing, structural health, security monitoring, environmental monitoring, smart agriculture, transportation, commercial applications, localization, tracking systems and other important and emerging applications. **WiSNet2023** is intended to stimulate discussion and foster innovation on these components and applications.

**WiSNet2023 Chair**
Rahul Khanna, *Intel*

**WiSNet2023 Co-Chair**
Paolo Mezzanotte, *University of Perugia*

### WISNET2023 Technical Program Committee

**Wireless Sensors for IoT Communication and Applications:**

| | |
|---|---|
| Georg Fischer | Tuami Lasri |
| Federico Alimenti | Reinhard Feger |
| Davi Valerio de Queiroz Rodrigues | |

**Wireless Sensors for Radar, Positioning, Tracking, and Imaging:**

| | |
|---|---|
| Alexander Koelpin | Paolo Mezzanotte |
| Changzhi Li | Zahir Alsulaimawi |
| Arne Jacob | Mario Pauli |
| Hendrik Rogier | Valentina Palazzi |
| Spyridon Daskalakis | |

**Wireless Sensors Circuits & System Technologies:**

| | |
|---|---|
| Alessandra Costanzo | Diego Masotti |
| Wang Wang | J-C Chiao |
| Serioja Tatu | Fabian Lurz |
| Guoan Wang | |

**WSN Hardware-Software CoDesign:**

| | |
|---|---|
| Amr Fahim | Manos Tentzeris |
| Jennifer Williams | Kamal Samanta |
| Nils Pohl | Emanuele Cardillo |

**Innovations in Wireless Sensor Networks:**

| | |
|---|---|
| Marco Dionigi | Rahul Khanna |
| Luciano Tarricone | Maurizio Bozzi |
| Xianming Qing | Kai-Ten Feng |
| Xuyu Wang | |

IEEE Internet of Things Summit

## IEEE Internet of Things (IoT) Summit at RWW2023

### 25 January – 3 February 2023

The 6th IEEE Internet of Things (IoT) Vertical and Topical Summit at RWW2023 is a six-day event. The program will be delivered in two parts. The first part is a hybrid event consisting of two sessions on the afternoon of January 25, 2023, held face to face in Las Vegas, Nevada USA, and virtually live online from remote locations. The second part is a week of virtual live online single daily sessions from January 30 – February 3, 2023.

The theme for the IEEE IoT V&T Summit at RWW2023 is "Quantum Information Technologies for IoT"

The Summit is meant to be highly interactive, and each session is composed of three to four speakers and a moderated panel discussion with audience participation. For the final session on Friday, February 3, 2023, we will conduct a virtual roundtable discussion led by a moderator and use both prepared and open questions from the attendees. The Summit seeks to provide a balance of perspectives, and the speakers include experts from industry, government, the research community, and experienced end-users. You can expect the presentations and discussions to address technical, business, and operational issues.

We hope to make the Summit as interactive as possible and look forward to your participation. If you are a policy maker, a strategist, a corporate manager, administrator, product developer, an IoT or mmWave engineer, a technologist, researcher, educator, working in industry, government, or academia, or just curious about IoT, wireless sensors, and communications systems, you will find the summit stimulating and rewarding. We look forward to seeing you online or in Las Vegas.**iot.ieee.org/program/**.

## REGISTRATION HOURS:

**Registration will be open during the following times in the Conference Center Foyer:**

**Sunday, 22 January 2023 10:00AM – 5:00PM**

**Monday, 23 January 2023 7:00AM – 5:00PM**

**Tuesday, 24 January 2023 7:00AM – 5:00PM**

**Wednesday, 25 January 2023 7:00AM – 12:00PM**

## EXHIBIT HOURS:

**The joint RWW/ARFTG Exhibition area in the Celebrity Ballroom 4-8 will be open during the following times:**

**Monday, 23 January 2023 1:00PM – 7:00PM**

**Tuesday, 24 January 2023 9:00AM – 5:00PM**

**Please refer to the conference website at http://www.radiowirelessweek.org/exhibits for the latest information and details on how to become a sponsor and exhibit at RWW.**

## SOCIAL EVENTS:

**Joint RWW/ARFTG Welcome Reception**

**Monday, 23 January 2023 5:30PM – 6:30PM**

**Location: Exhibit Hall – Celebrity Ballroom**

### NETWORKING OPPORTUNITIES/LITE RECEPTIONS:

**Sunday 22 January 2023 at 6:00 PM before the WiM event**

# Sunday, 22 January 2023

## 1:30-5:30 PM

### Workshop on RF and mmW Devices, Circuits and Systems for Low Earth Orbit Missions

**Organizer:**
Jan Budroweit, *DLR, Germany*

Room: Melrose 1&2

**Abstract:**
The half-day workshop will introduce a global coverage of latest RF and mmW devices, circuits and systems that are desired for low Earth orbit (LEO) missions or that already have proven flight heritage in space. Specific topics of this workshops are space system design under consideration of radiation effects, user terminals for new space LEO constellations, LEO based mmW radar concepts for earth science applications and a recap of the CubeSat mission of the technical university Berlin.

**Program:**

**Space System Design under Consideration of Radiation Effects**
Jan Budroweit, *DLR*

**30 years of satellite development at Technische Universität Berlin**
Julian Bartholomäus, *TU Berlin*

**LEO based mmWave radar concepts for earth science applications**
Srinivas Prasad, *NASA JPL*

**User Terminal for new space LEO Constellations**
Arnaldo Oliveira, *Universidade de Aveiro*

### Workshop on Radar-based vital sign sensing – the latest trends

**Organizer:**
Fabian Michler, *FAU Erlangen-Nuremberg / Sykno GmbH*

Room: Melrose 3

**Abstract:**
During the past decade, vital sign sensing radars have become a quickly growing research topic in microwave engineering, promising the contactless and therefore patient-friendly measurement of various vital signs. This workshop explains the fundamentals of the research by introducing the underlying physiology of heartbeat and respiration, the resulting body surface movements and vibrations. System design challenges and limitations will be explained on the example of highprecision continuous-wave radars. Moreover, the challenges and outcomes of long-term studies in hospitals and home-care will be shared with the audience. Focused talks provide insights into the latest developments. This includes research in the field of passive sensing systems, which analyze ambient wireless signals, such as Bluetooth or Wi-Fi, to extract vital sign signals. Moreover, a commercial system for microwave-based blood pressure measurement will be presented, including a live demonstration.

**Program:**

**Fundamentals and System Design Challenges for Radar-Based Vital Sign Sensing**
Fabian Michler, *University Erlangen-Nuremberg / Sykno GmbH*

**Interferometric Radar for Cardiovascular Monitoring**
Nils Albrecht, *Hamburg University of Technology*

**Observations from using mm-Wave Radars in Hospitals & Long-Term Care Homes**
George Shaker, *University of Waterloo*

**Passive Radar Sensing for Motion Detection using Ambient Wireless Signals**
Aaron Carman, Changzhi Li, *Texas Tech University*

**Blood Pressure Monitoring**
Christoph Will, *Infineon Technologies*

### Workshop on D-Band FMCW Radar – Basics and Signal Processing

**Organizer:**
Timo Jaeschke, *2π-LABS*

Room: Melrose 4

**Abstract:**
This half-day workshop aims to introduce the general FMCW radar basics in terms of hardware system level design and signal processing for industrial radar applications. First, a general overview of the basic FMCW radar system design objectives and application fields is given. This is followed by an insight into the most critical hardware design challenges and ways to avoid common design mistakes. A lot of examples are given in terms of a state-of-the-art D-Band wideband radar sensor as an example implementation. The second part of the workshop provides a unique hands-on high-end radar experience and you will learn how to process IF signals, extract precise distance measurements from the range-plot signals or how to produce range doppler plots. A lot of Python language programming examples will be provided and live sensor data or live measurements are utilized to create a fun learning experience. This workshop will provide you with a well equipped toolbox for a smooth start into the FMCW radar signal processing world for the next >95 GHz EHF industrial radar generation.

**Program:**

**Wideband FMCW Radar – An Introduction**
Timo Jaeschke, *2π-LABS*

**Wideband Radar Hardware Design Aspects**
Simon Küppers, *2π-LABS*

**FMCW Radar Signal Processing & Hands-On**
Jan Barowski, Timo Jaeschke, Simon Küppers, *2π-LABS*

### Workshop on Health Aspects of Millimeter-Wave Radiations in 5G and Beyond

**Organizers:**
Abbas Omar, *Uni Magdeburg*

Room: Melrose A&B

**Abstract:**

Utilizing Millimeter Waves in mobile communications is associated with much lower radiation powers and much shorter communication ranges. This gives rise to what are called "Microcells" and "Picocells", whose coverage areas don't exceed few meters. These cells are responsible for the communication with the User Equipment (UE). Their backhaul communications with high-power Base Stations (BS) are either wired (usually fiber-optical) or in a Line-of-Sight (LOS) scenario. LOS wireless communications don't involve wave-matter interactions, as any LOS obstacle heavily deteriorates the communication quality. Health aspects of 5G and beyond is therefore limited to the extremely low-power short-range Picocell-UE communication.

A group of very competent scientists will talk at this Workshop. These represent Standardization Institutions, academic scientists involved in health issues of electromagnetic radiations, and physicists, who can qualitatively estimate the in-vivo radiation levels and the electromagnetic loss mechanisms dominating the wave-matter interactions in biological substances.

Both calming and alarming arguments will be presented in a fairly balanced manner. Except for few minor aspects that still need further investigations, most systematic and objective evaluations tend to consider the currently accepted and applied radiation limits safe enough. This doesn't underestimate or deny at all the claims known as "Electromagnetic Hypersensitivity", which remain subjective, until having solid scientific explanations.

**Program:**

**RF Exposure Levels from Mobile Phones and Base Stations**
C-K. Chou and K. Foster

**Considerations on RF Electromagnetic Waves Exposure Systems to Evaluate their Impact on Cells**
K. Grenier and D. Dubuc

**New Challenges Related to 5G Bio- electromagnetic Exposure for Laboratories Studies**
D. Arnaud-Cormos and Ph. Leveque

**Health Aspects of 5G Antennas: Current Low-Level Evidences and Experimental Design Strategies**
S. Costanzo

## 6:30-8:00 PM

### WOMEN IN MICROWAVES EVENT
### DISTINGUISHED WOMEN IN MICROWAVES

Room: Melrose 1 & 2

**The Women in Microwaves (WiM) event** will spotlight distinguished professionals who have considerably advanced the fields of microwave theory and technology and automatic radio frequency (RF) techniques. Three outstanding presenters will deliver talks describing their respective research fields. Dr. Malgorzata Celuch, QWED, Warsaw, Poland, will present **"Modeling-Based Characterization of Materials From Microwaves to Millimeter Waves."**

Prof. Rhonda R. Franklin, University of Minnesota (UMN), Minneapolis, USA, will present **"Advances in Wired and Wireless Interconnect Technology for Microwave and Sub-Millimeter-Wave Applications."** Finally, Prof. Qiaowei Yuan, Tohoku Inst itute of Technology, Miyagi, Japan, will present **"Direction-of-Arrival Estimation and Array Antenna Beamforming With Mutual Coupling.**

## DISTINGUISHED MICROWAVE LECTURERS' TALKS

**Organizer: Markus Gardill,** ***Brandenburg University of Technology***

Room: Celebrity 5

**8:00-8:45 AM**

**Mo1D-1**

### Extreme Field Control with Electromagnetic Metasurfaces

**Lecturer: Anthony Grbic,** ***University of Michigan, USA***

The research area of metamaterials has captured the imagination of scientists and engineers over the past two decades by allowing unprecedented control of electromagnetic fields. The extreme manipulation of fields has been made possible by the fine spatial control and wide range of material properties that can be attained through subwavelength structuring. Research in this area has resulted in devices which overcome the diffraction limit, render objects invisible, and even break time reversal symmetry. It has also led to flattened and conformal optical systems and ultra-thin antennas. This seminar will identify recent advances in the growing area of metamaterials, with a focus on metasurfaces: two dimensional metamaterials. The talk will explain what they are, the promise they hold, and how these field-transforming surfaces are forcing the rethinking of electromagnetic/optical design.

Electromagnetic metasurfaces are finely patterned surfaces whose intricate patterns/textures dictate their electromagnetic properties. Conventional field-shaping devices, such as lenses in prescription eye glasses or a magnifying glass, require thickness (propagation length) to manipulate electromagnetic waves through interference. In contrast, metasurfaces manipulate electromagnetic waves across negligible thicknesses through surface interactions, by impressing abrupt phase and amplitude discontinuities onto a wavefront. The role of the visible (propagating) and invisible (evanescent) spectrum in establishing these discontinuities will be explained. In addition, it will be shown how metasurfaces allow the complete transformation of fields across a boundary, and how this unique property is driving a new generation of ultra-compact electromagnetic and optical devices with unparalleled field control. Metasurfaces will be described that exhibit various field tailoring capabilities including multiwavelength and multifunctional performances and extreme field shaping. In addition, metasurfaces with multi-input to multi-output capabilities will be presented that open new opportunities in adaptive and trainable designs.

**8:45-9:30 AM**

**Mo1D-2**

### Multi-Function Multi-Band Reconfigurable High-Q Filters

**Lecturer: Raafat R. Mansour,** ***University of Waterloo, Canada***

Reconfigurable filters are key components in the development of agile multi-standard receivers. The advent of innovative switched capacitor arrays and switch technologies based on semiconductor SOI, Micro-Electro-Mechanical Systems (MEMS) and Phase Change Material (PCM) technologies permits the development of a new generation of high linearity, low loss, and low power consumption tunable components. This talk starts by addressing the needs for using multi-band and tunable filters in wireless communication systems and in flexible satellite payloads. It then addresses existing tuning technologies, providing a comparison between piezoelectric, Semiconductor, MEMS and PCM tuning elements in terms of linearity, insertion loss, suitability for use at millimeter-wave frequencies and ease of integration with high-Q filters. It outlines major design considerations for tunable filters presenting techniques to realize tunable filters with an absolute constant absolute bandwidth and a constant frequency spacing between transmission zeros, over a wide tuning range. The talk also illustrates examples of tunable filters and diplexers tuned only a by single tuning element, while exhibiting a constant absolute bandwidth. It then addresses approaches for realizing multi-band filters including dual-band and triple-band filters. Finally, it presents techniques for realizing multi-band filters where the various bands are tunable in both center frequency and bandwidth. Very recent work on realizing reconfigurable acoustic filters is also presented.

**10:10-10:55 AM**

**Mo1D-3**

### mm-Wave System and Circuit Design for Highly-Integrated Radar Transceivers

**Lecturer: Vadim Issakov,** ***Technische Universitat Braunschweig, Germany***

There is a growing interest in realization of highly-integrated radar transceivers operating at millimeter-wave (mm-wave) frequencies. The need for high-level integration is driven by the motivation for the products to be competitive on the market, this means implementing more features, offer high digital reconfigurability and enhanced RF functionality, consume a minimal chip area, dissipate less power and achieve a lower price. The trend in integrated mm-wave radar systems goes towards using increasingly higher operating frequencies. Frequencies above 100 GHz are very attractive for realizing multi-channel radar systems, due to possibility of module size reduction thanks to scaling of the antennas.

This talk focusses on system and circuit design considerations for highly-integrated radar transceivers in CMOS and SiGe HBT technologies. The speaker will first provide motivation for realization of radar sensors at mm-wave frequencies by showing the possible applications. Then, frequency band allocations for radar at mm-wave frequencies are discussed. Next, speaker will discuss system level consideration in detail and will present step-by-step system design steps for an integrated fast-chirp FMCW radar transceiver, such as level budget calculation, phase noise considerations, PLL linearity, design of the analog baseband. The system considerations will be systematically translated into specifications of circuit blocks (e.g. LNA, mixer, PA, VCO, analog baseband etc.) of the radar transceiver.

Additionally, digital modulation techniques such as phase-modulated continuous-wave (PMCW) will be discussed and a systematic comparison with FMCW will be given.

Next, technology-dependent considerations and challenges related to critical building blocks are discussed (e.g. phase noise, noise figure, operating frequency, routing density, digital baseband). Then, the speaker will present several design examples of integrated radar transceivers operating at V-band and D-band and will discuss the circuit architectures. The talk is rounded out by a vision on novel modulation techniques and trends in MIMO radar array realizations.

**10:55-11:40 AM**

**Mo1D-4**

### Quantum Computing: What Is It, How Does It Work, And What Are The Opportunities For Microwave Engineers?

**Lecturer: Joseph Bardin,** ***University of Massachusetts Amherst***

Quantum computing offers the potential for an exponential speed-up of certain classes of computational problems, and, as such, the development of a practical quantum computer has been a field of intense research over the past two decades. Yet, it is still early in the development of these systems, as we have just reached the point at which laboratory experiments have shown that quantum computers can outperform classical computers at certain computational tasks. As such, it is an exciting time in the field, analogous to the early days of classical computer development. As microwave engineers there is a tremendous opportunity to contribute to quantum computing, as the control and measurement of most quantum processors is carried-out using microwave techniques. In this talk, I will describe the use of microwaves in quantum computing, with a focus on the superconducting qubit technology which was used to show that a quantum computer is capable of post-classical computation. The talk will be geared toward microwave engineers with no background in quantum computing and will provide a glimpse into the fundamentals, contemporary system architectures, recent experiments, and, finally, major microwave challenges that must be overcome if fault tolerant quantum computing is to become a reality. While the "quantum" aspects of quantum computing will be described, the deeper technical discussion will focus on the specification and design of the microwave control and measurement systems required to operate these systems, using Google's state-of-the-art Sycamore quantum computer as an example. Ongoing research in scalable control and measurement electronics will also be described.

# Monday, 23 January 2023

## RWS Session Mo1A

### COMMUNICATION SYSTEMS

**Chair: Vadim Issakov**

**Co-Chair: Alexander Kölpin**

Room: Melrose 1 & 2

## PAWR Session Mo1B

### CHARACTERIZATION AND MODELLING

**Chair: Vittorio Camarchia**

**Co-Chair: Valeria Brunel Di Giacomo**

Room: Melrose 3

## SiRF Session Mo1C

### FREQUENCY CONVERTERS AND SYSTEMS

**Chair: Austin Chen**

**Co-Chair: Roee Ben Yishay**

Room: Melrose 4

**8:00-9:40 AM**

**Mo1A-1**

**Investigation and Optimization of Secrecy Capacity for Intelligent Reflective Surfaces-Assisted Secure mmWave Indoor Wireless Communication**

*Authors: Ozlem Yildiz, New York University Tandon School of Engineering; Mohammad Alavirad, Dell Technologies; Tejinder Singh, Dell Technologies*

**Mo1A-2**

**Synchronising Clock and Carrier Frequencies with Low and Coherent Phase Noise for 6G**

*Authors: Zichuan Zhou, University College London; Dhecha Nopchinda, University College London; Izzat Darwazeh, University College London; Zhixin Liu, University College London*

**Mo1A-3**

**Performance Analysis for Coded Wireless Steganography System With OFDM Signaling**

*Authors: Yuto Hama, Yokohama National University; Kazuaki Hanazawa, Yokohama National University; Hideki Ochiai, Yokohama National University; Junji Shikata, Yokohama National University*

**Mo1A-4**

**On radio signatures to mitigate the MAC addresses randomization for Wi Fi analytics in real-world scenarios**

*Authors: Abraham Pérez-Hernández, Galgus; Maydelis N Barreras-Martín, Galgus; Jesús Fernández-Manzano, Galgus; Pablo Aguilera, Galguse*

**Mo1B-1**

**Precision DPD Characterization of Amplifiers Under Modulated Drive Using Advanced VNA Methods**

*Author: Joel Dunsmore*

**Mo1B-2**

**A Novel Cardiff Model Coefficients Extraction Process Based on Artificial Neural Network**

*Authors: Mengyue Tian, Cardiff University; James J Bell, Cardiff University; Ehsan Azad, Cardiff University; Roberto Quaglia, Cardiff University; Paul J Tasker, Cardiff University*

**Mo1B-3**

**Characterization of GaN Power Amplifier Using 5G mm-Wave Modulated Signals**

*Authors: Lucas Letailleur, Université Gustave Eiffel, CNRS, ESYCOM, F-77454; Martine Villegas, Université Gustave Eiffel, CNRS, ESYCOM, F-77454; Ahmad Al Hajjar, OMMIC; Charles Edoua Kacou, OMMIC*

**Mo1C-1**

**RF to Millimeter-Wave N-path Filters and Receivers**

*Author: Brian Floyd, North Carolina State University*

**Mo1C-2**

**A Highly Linear D-Band Broadband Down Conversion Mixer in 22-nm FDSOI CMOS**

*Authors: Kaan Balaban, Karlsruhe Institute of Technology; Matthias Moeck, Karlsruhe Institute of Technology; Cagri Ulusoy, Karlsruhe Institute of Technology*

**Mo1C-3**

**A 42.24 Gb-s Channel Bonding Up-Converter withintegrated multi-LO generation in 45nm CMOS**

*Authors: Alexandre Siligaris, Université Grenoble-Alpes, CEA-Leti; Pierre Courouve, Université Grenoble-Alpes, CEA-Leti; Guillaume Waltener, Université Grenoble-Alpes, CEA-Leti; Abdelaziz Hamani, University of Grenoble-Alpes France; Cedric Dehos, Université Grenoble-Alpes, CEA-Leti; Jose Luis Gonzalez-Jimenez, Université Grenoble Alpes - CEA, LETI*

**Mo1C-4**

**A 60-GHz CMOS Broadband Heterodyne I-Q Up-Converter with Suppressed LO-Feedthrough and Image Leakages**

*Authors: Kyung Pil Jung, Korea Advanced Institute of Science and Technology; Seung Hun Kim, Samsung Research Korea; Chul Soon Park, Korea Advanced Institute of Science and Technology*

## RWS Session Mo2A

### 5G AND THZ COMMUNICATION: COMPONENTS AND CIRCUITS

**Chair: Nuno Carvalho**

**Co-Chair: Holger Maune**

Room: Melrose 1 & 2

## PAWR Session Mo2B

### POWER AMPLIFIERS SOLUTIONS FOR COMMUNICATION SYSTEMS

**Chair: Frederick Raab**

**Co-Chair: Chris Sanabria**

Room: Melrose 3

## SiRF Session Mo2C

### MILLIMETER-WAVE SYSTEMS

**Chair: Kamel Haddadi**

**Co-Chair: Timo Jaeschke**

Room: Melrose 4

**10:10-11:50 AM**

**Mo2A-1**

**Image-Rejection Up-/Down-Converter LO Distribution Chain for 5G mm-wave Phased-Array Systems**

*Authors: Aniello Franzese, IHP GmbH; Nebojsa Maletic, IHP GmbH; Renato Negra, RWTH Aachen University; Andrea Malignaggi, IHP Microelectronics*

**Mo2A-2**

**A 38GHz SPDT Traveling Wave Switch with 5A CDM ESD Protection in 45nm PDSOI for 5G System**

*Authors: Mengfu Di, University of California, Riverside; Weiquan Hao, University of California, Riverside; Zijin Pan, University of California, Riverside; Xunyu Li, University of California, Riverside; Runyu Miao, University of California, Riverside; Albert Wang, University of California, Riverside*

**Mo2A-3**

**A Low-Power Push-Push D-Band VCO with 11.6% FTR utilizing Back-gate Control in 22nm FDSOI**

*Authors: Yasir Shafiullah, University of Oulu; Mikko Hietanen, University of Oulu; Rehman Akbar, University of Oulu; Marko E Leinonen, University of Oulu; Janne Aikio, University of Oulu; Jere Rusanen, University of Oulu; Timo Rahkonen, University of Oulu; Aarno Pärssinen, University of Oulu*

**Mo2A-4**

**Infinity Additive Manufacturing of Polarization Maintaining Fibers for THz Communications**

*Authors: Guofu Xu, Polytechnique Montreal; Kathirvel Nallappan, Polytechnique Montreal; Yang Cao, École Polytechnique de Montréal; Maksim Skorobogatiy, Polytechnique Montreal*

**Mo2A-5**

**Characterization of a Flexible Polymer-Based Substrate Material for RF Applications**

*Authors: Fabian Michler, Friedrich-Alexander-Universität Erlangen-Nürnberg; Jasmin Kolpak, Friedrich-Alexander-Universität Erlangen-Nürnberg; Benedict Scheiner, Friedrich-Alexander-Universität Erlangen-Nürnberg; Robert Weigel, Friedrich-Alexander-Universität Erlangen-Nürnberg; Amelie Hagelauer, Technical University of Munich*

**Mo2B-1**

**Comments on Applications of Digital Predistortion in 5G Transmitters**

*Author: John Wood*

**Mo2B-2**

**A 160-GHz, 10-dBm power amplifier for D-band communication in 0.1-µm GaAs pHEMT**

*Authors: Tatsuya Soma, NEC Corporation; Masaharu Ito, NEC Corporation; Yasushi Wada, NEC Corporation*

**Mo2B-3**

**Continuous Inverse Class-F GaN Power Amplifier with 70% Efficiency over 1.4-2 GHz Bandwidth**

*Authors: Anna Piacibello, Politecnico di Torino; Zhifan Zhang, Politecnico di Torino; Vittorio Camarchia, Politecnico di Torino*

**Mo2B-4**

**Broadband Outphasing Power Amplifier Using Doherty-Chireix Continuum in a GaN MMIC Process**

*Authors: Dominic Mikrut, Ohio State University; Patrick Roblin, Ohio State University; Chenyu Liang, Ohio State University; Shane Smith, SenseICs; Ramy Tantawy, SenseICs*

**Mo2C-1**

**Beamformers and Transceivers for mmWave 5G in Silicon Technologies**

*Author: Erik Ojefors, Sivers Semiconductors*

**Mo2C-2**

**CMOS mm-Wave Systems on Chip Technology for Exploring Earth, the Solar System and Space**

*Author: Adrian Tang, NASA's Jet Propulsion Lab*

**Mo2C-3**

**A Wideband Four-Channel SiGe D-Band Transceiver MMIC For TDM MIMO FMCW Radar**

*Authors: Hakan Papurcu, Ruhr University Bochum; Justin Romstadt, Ruhr University Bochum; Steffen Hansen, Fraunhofer FHR; Christian Krebs, Fraunhofer FHR; Klaus Aufinger, Infineon Technologies AG; Nils Pohl, Ruhr University Bochum*

## RWS Session Mo3A

### BIOMEDICAL APPPLICATION OF MICROWAVES

**Chair: Robert Caverly**

**Co-Chair: Changzhi Li**

Room: Melrose 1 & 2

## PAWR Session Mo3B

### LINEARIZATION AND EFFICIENCY ENHANCEMENT TECHNIQUES

**Chair: Pere Gilabert**

**Co-Chair: Anding Zhu**

Room: Melrose 3

## SiRF Session Mo3C

### OSCILLATORS AND DIVIDERS

**Chair: Amit Jha**

**Co-Chair: Roee Ben Yishay**

Room: Melrose 4

**1:30-3:10 PM**

**Mo3A-1**

**A GaAs LNA MMIC for a Correlation-Dicke Radiometer Internal-Body Temperature Sensor**

*Authors: Jooeun Lee, University of Colorado; Zoya Popovic, University of Colorado*

**Mo3A-2**

**Long-Distance Heart Sound Detection using 122 GHz CW Radar with 3D Printed High-Gain Antennas**

*Authors: Nils C Albrecht, Hamburg University of Technology; Markus Heyder, Hamburg University of Technology; Marvin Wenzel, Hamburg University of Technology; Dominik Langer, Hamburg University of Technology; Hui Lu, Brandenburg University of Technology; Alexander Koelpin, Hamburg University of Technology*

**Mo3A-3**

**Effect of Phase Noise in FMCW and PMCW Radar Systems for Breast Cancer Detection**

*Authors: Martin Maier, Technische Universität Braunschweig; Finn-Niclas Stapelfeldt, Technische Universität Braunschweig; Vadim Issakov, Technische Universität Braunschweig*

**Mo3A-4**

**Portable Real-Time System for Multi-Subject Localization and Vital Sign Estimation**

*Authors: Vijaysrinivas Rajagopal, University of Tennessee; Abdel-Kareem Moadi, University of Tennessee; Aly Fathy, University of Tennessee; Mongi A Abidi, University of Tennessee*

**Mo3B-1**

**Rational Generalized Memory Polynomial for Efficient Predistortion of Wideband Envelope Tracking Amplifiers**

*Authors: Paul Draxler, Stonecrest Consulting; Martin Navaroli, MaXentic Technologies, LLC; Dane J Malangone, MaXentric Technologies, LLC; Edward Falcon, MaXentric Technologies, LLC; Eric Brown, MaXentric Technologies, LLC; Jonmei J Yan, MaXentric Technologies, LLC*

**Mo3B-2**

**Frequency-Dependent DPD Linearization for Load-Mismatched Mobile Terminal PAs Operating Under Dynamic Resource Block Allocation**

*Authors: Wantao Li, University Politècnica de Catalunya; Gabriel Montoro, University Politècnica de Catalunya; Yan Guo, HiSilicon; Pere L. L Gilabert, University Politècnica de Catalunya*

**Mo3B-3**

**Sparse Regression of Power Amplifier Behavioral Models with a Stagewise Doubly Orthogonal Matching Pursuit**

*Authors: Juan A. A Becerra, Universidad de Sevilla; Miguel Nogales, Universidad de Sevilla; Elías Marqués-Valderrama, Universidad de Sevilla; Maria J. Madero-Ayora, Universidad de Sevilla*

**Mo3B-4**

**Efficiency versus linearity trade-off in an S-band class-AB power amplifier**

*Authors: Zhifan Zhang, Politecnico di Torino; Anna Piacibello, Politecnico di Torino; Vittorio Camarchia, Politecnico di Torino*

**Mo3B-5**

**A 3.7-4.2GHz MMIC Doherty Power Amplifier Linearized over 500MHz Instantaneous Bandwidth**

*Authors: Alexis Courty, Ampleon; Christophe Quindroit, Ampleon; Jean-Jacques Bouny, Ampleon; Pierre Ferris, Ampleon; Pablo Rochas, Ampleon; Xavier Moronval, Ampleon*

**Mo3C-1**

**ADPLL's – once you go digital you probably won't go back**

*Authors: Run Levinger, Intel Corporation; Evgeny Shumaker, Intel Corporation; Aryeh Farber, Intel Corporation; Sergey Bershansky, Intel Corporation; Rotem Banin; Ashoke Ravi; Gil Horovitz, Intel Corporation; Ofir Degani, Intel Corporation*

**Mo3C-2**

**A Tunable SiGe BiCMOS Quadrature LO Source with 31% Tuning Range for L, C and X-band Space-borne Remote Sensing**

*Authors: Maciej J Kucharski, SIRC; Maciej Klemm, SIRC; Radosław Piesiewicz, SIRC; Vaclav Valenta, European Space Agency*

**Mo3C-3**

**Low Power CMOS VCO Using an 8-shaped Transformer**

*Authors: Ho-Chang Lee, National Taiwan University of Science and Technology; sheng-lyang jang, National Taiwan University of Science and Technology; Ren-Xiang Yang, National Taiwan University of Science and Technology*

**Mo3C-4**

**A Low Power 100 GHz Static CML Frequency Divider in 0.18 µm SiGe BiCMOS Technology**

*Authors: Hao-Yu Chien, University of California, Los Angeles; Christopher Chen, University of California, Los Angeles; Jason Woo, University of California, Los Angeles; Sudhakar Pamarti, University of California, Los Angeles; Chih-Kong Ken Yang, University of California, Los Angeles; Mau-Chung Frank Chang, University of California, Los Angeles*

## RWS Session Mo4A

### RADAR SIGNAL PROCESSING AND CHANNEL ESTIMATION

**Chair: Markus Gardill**

**Co-Chair: Arnaldo Oliveira**

Room: Melrose 1 & 2

## PAWR Session Mo4B

### LATE NEWS

**Chair: Patrick Roblin**

**Co-Chair: Anna Piacibello**

Room: Melrose 3

## SiRF Session Mo4C

### DEVICE MODELING

**Chair: Mehmet Kaynak**

**Co-Chair: Austin Chen**

Room: Melrose 4

**3:40-5:20 PM**

**Mo4A-1**

**Out-of-Distribution Detection for Radar-based Gesture Recognition Using Metric-Learning**

*Authors: Thomas Stadelmayer, Friedrich-Alexander-Universität Erlangen-Nürnberg; Lorenzo Servadei, Infineon Technologies AG; Avik Santra, Infineon Technologies AG; Robert Weigel, Friedrich-Alexander-Universität Erlangen-Nürnberg; Fabian Lurz, Technische Universität Hamburg*

**Mo4A-2**

**Automotive Radar Channel Simulation based on a High-Resolution Backscattering Model of a Motorcyclist**

*Authors: Sevda Abadpour, Karlsruhe Institute of Technology (KIT)-IHE; Mario Pauli, Karlsruhe Institute of Technology (KIT)-IHE; Xueyun Long, Karlsruhe Institute of Technology (KIT)-IHE; Thomas Zwick, Karlsruhe Institute of Technology*

**Mo4A-3**

**Accurate Heart Beat Detection with Doppler Radar using Bidirectional GRU Network**

*Authors: Hui Lu, Brandenburg University of Technology; Markus Heyder, Hamburg University of Technology; Marvin Wenzel, Hamburg University of Technology; Nils C Albrecht, Hamburg University of Technology; Dominik Langer, Hamburg University of Technology; Alexander Koelpin, Hamburg University of Technology*

**Mo4A-4**

**Prediction and Simulation of FMCW Radar Hand Gesture Detection based on Captured 3D Motion Data**

*Authors: Christopher Williams, Texas Tech University; Changzhi Li, Texas Tech University*

**Mo4A-5**

**Quantization Effects in a CNN-based Channel Estimator**

*Authors: Fábio L Coutinho, Instituto De Telecomunicacoes; Hugerles S Silva, Instituto De Telecomunicacoes; Petia Georgieva, University of Aveiro; Arnaldo R Oliveira, University of Aveiro*

**Mo4B-1**

**A Comparison Study on the Broadband Performance of Load-Modulated Architectures using Nonlinear Embedding at 20 GHz**

*Authors: Dominic Mikrut, Ohio State University; Patrick Roblin, Ohio State University; Miles Lindquist, Ohio State University; Nicholas C Miller, Air Force Research Laboratory; David Frey, CAES*

**Mo4B-2**

**A Reliable 5G Stacked Power Amplifier in 45nm CMOS Technology**

*Authors: Zhize Ma, Purdue University; Saeed Mohammadi, Purdue University*

**Mo4B-3**

**Extending the Inverse Model Range of Applicability for Efficient Predistortion of Wideband Envelope Tracking Amplifiers**

*Authors: Paul Draxler, Stonecrest Consulting; Martin Navaroli, MaXentic Technologies, LLC; Dane J Malangone, MaXentric Technologies, LLC; Edward Falcon, MaXentric Technologies, LLC; Eric Brown, MaXentric Technologies, LLC; Jonmei J Yan, MaXentric Technologies, LLC*

**Mo4B-4**

**High-Efficiency Watt-Level E-band GaN Power Amplifier with a Compact Low-loss Combiner**

*Authors: Bharath kumar Cimbili, Fraunhofer Institute for Applied Solid State Physics; Christian Friesicke, Fraunhofer Institute for Applied Solid State Physics; Friedbert van Raay, Fraunhofer Institute for Applied Solid State Physics; Sandrine Wagner, Fraunhofer Institute for Applied Solid State Physics; Mingquan Bao, Ericsson; Ruediger Quay, Fraunhofer Institute for Applied Solid State Physics*

**Mo4C-1**

**RF figures of merit of polysilicon trap-rich layers formed locally by ion amorphization and nanosecond laser annealing**

*Authors: Martin Perrosé, Université Grenoble Alpes - CEA, LETI; Pablo acosta alba, Université Grenoble Alpes - CEA, LETI; Maxime Moulin, CEA-LETI; Emmanuel Augendre, Université Grenoble Alpes - CEA, LETI; Jose Lugo, Université Grenoble Alpes - CEA, LETI; Jean-Pierre Raskin, Universite Catholique of Louvain la Neuve; Shay Reboh, Université Grenoble Alpes - CEA, LETI*

**Mo4C-2**

**Buried PN Junctions Impact on the Performances of an Inductor at RF Frequencies in the presence of Parasitic Surface Conduction**

*Authors: Thibaud Fache, CEA-LETI; Maxime Moulin, CEA-LETI; Ismael Charlet, CEA-LETI; Zdenek Chalupa, CEA-LETI; Jean-Pierre Raskin, University Catholiqué de Louvain; Frédéric Allibert, Soitec; Christophe Plantier, CEA-LETI; Fred Gaillard, CEA-LETI; Louis Hutin, CEA-LETI*

**Mo4C-3**

**22-nm FDSOI CMOS Noise Modeling and Analysis in mm-Wave Frequency Range**

*Authors: Quang Huy Le, Fraunhofer-Gesellschaft; Dang Khoa Huynh, Fraunhofer IPMS; Steffen Lehmann, GLOBALFOUNDRIES; Zhixing Zhao, GLOBALFOUNDRIES; Christoph Schwan, GLOBALFOUNDRIES; Thomas Kaempfe, Fraunhofer-Gesellschaft; Matthias Rudolph, Brandenburg University of Technology*

**Mo4C-4**

**Simulation of Built-In Test Equipments based on Avalanche Noise Diodes: Ka-band LNA Case Study**

*Authors: Guendalina Simoncini, University of Perugia; Federico Alimenti, University of Perugia*

**6:30-7:30 PM**

## PANEL SESSION

### THE ROAD TO D BAND IS FULL OF GOOD INTENTIONS…

**Room: Celebrity 5**

**Abstract**

D-band promises to be the next big thing for the microwave community, with speculations on 6G targeting it as one of its frequencies, and many other applications emerging that will exploit the enormous bandwidths available and the intrinsic security features.

To successfully use the D-band, the microwave community will ask the semiconductor foundries to supply technology that can provide at these frequencies and demand instrumentation that can characterize devices and systems accurately.

This panel is a great opportunity to start posing your questions to experts from foundries and instrumentation suppliers and hear what their approach and solutions are to overcome the obstacles on the road to D-band.

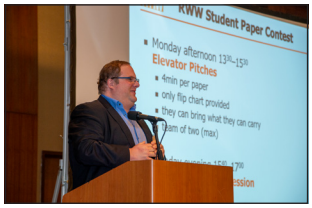
**Moderators:**

Roberto Quaglia, *Cardiff University, UK*
Vittorio Camarchia, *Politecnico di Torino, Italy*

**Panelists:**

Chris Sanabria, *Qorvo, US, III-V foundry*
Harris Moyer, *HRL US , III-V foundry*
David Danzilio, *WIN Semiconductors, Taiwan , III-V foundry*
Remy Leblanc, *OMMIC, France, III-V foundry*
Valeria Brunel Di Giacomo, *UMS, France/Germany , III-V foundry*
Eduard Preisler, *Tower Jazz Semiconductior, US , SiGe foundry*
Jon Martens, *Anritsu, US , Measurement Instruments Supplier*
Marcus DaSilva, *National Instruments, US, Measurement Instruments Supplier*

# Joint RWW Student Paper Contest




**1:30 PM – 3:10 PM (Student Elevator Pitches)**
**3:40 PM – 5:20 PM (Student Poster Session)**

**Student Paper Contest Chairs:**

**Fabian Lurz, *Hamburg University of Techology***
**Ken Kolodziej, *MIT Lincoln Laboratory***

The RWW Student Paper Contest provides students with the opportunity to share their work and discuss their results with experts from industry and academia. The contest is open to all students attending the RWW and presenting a paper at one of the topical conferences (RWS, PAWR, WiSNet, SiRF, and SHaRC). Beginning in 2017, the RWW Steering Committee established a new format for the contest, making it a single event for the whole RWW. The finalists will be chosen from all the submitted student papers, and the two best papers representing the entire RWW will be awarded.

All finalists will give a five-minute elevator pitch and present a poster at the Finalists' Interactive Poster Session on Monday afternoon. Judges will grade the papers and presentations in the following areas: novelty of the research, quality of the oral presentation, quality of the poster, quantity and quality of information presented, preparedness of the presenter and the student's performance in the Q&A session. The two best student papers representing the entire RWW will be awarded at the Plenary Session, which takes place on Tuesday.

## Student Paper Competition Finalists

| PAPER NUMBER | TITLE | SPEAKER |
|---|---|---|
| Tu3A-1 | The Anglet: An E/H-plane Bent, 90-Degree Twisted, TE101/TM110-Mode Singlet Building Block | Chad Bartlett |
| We3B-3 | Optimizing the Coupling Factor of a Tapped Delay Line for Analog Radar Target Simulation | Kai Braungardt |
| Mo4B-4 | High-Efficiency Watt-Level E-band GaN Power Amplifier with a Compact Low-loss Combiner | Bharath kumar Cimbili |
| We4B-1 | Low-cost Software-Defined Radio System with Deterministic RX to TX Delay Using Timestamps | Christian Dorn |
| Tu3C-1 | Monolithically Integrated Optoelectronic Transmitter based on Segmented Mach-Zehnder Modulator in EPIC 250 nm BiCMOS Technology | Festim Iseini |
| We1A-2 | Chip-embedded Glass Interposer for 5G Applications | Xingchen Li |
| Mo3B-2 | Frequency-Dependent DPD Linearization for Load-Mismatched Mobile Terminal PAs Operating Under Dynamic Resource Block Allocation | Wantao Li |
| Mo4A-3 | Accurate Heart Beat Detection with Doppler Radar using Bidirectional GRU Network | Hui Lu |
| Mo4C-1 | RF figures of merit of polysilicon trap-rich layers formed locally by ion amorphization and nanosecond laser annealing | Martin Perrosé |
| Tu3C-2 | Automatic Tuning of Microwave Silicon Photonic Ring Resonators | Ramy Rady |
| We4B-2 | Theoretical Limits and Interpolation based Improvements of a Correlation Based True-Speed-Over-Ground Estimation | Torsten Reissland |
| Mo4A-1 | Out-of-Distribution Detection for Radar-based Gesture Recognition Using Metric-Learning | Thomas Stadelmayer |
| Tu1B-4 | A Low-Power V-Band CW Radar Transceiver with Vector Modulator for Leakage Cancellation | Batuhan Sutbas |
| We3B-1 | Full Polarimetric Antenna System for Automotive Radar | Alessandro Tinti |
| We2A-5 | Ultra-Wide Bandwidth Substrate Integrated Waveguide Fed Vivaldi Antenna in D-Band Using Glass Interposer | Lakshmi Narasimha Vijay Kumar |

## RWS Session Tu1A

### ADVANCED TUNABLE SOURCES AND FILTERS

**Chair: Holger Maune**

**Co-Chair: Roberto Gomez-Garcia**

Room: Melrose 1 & 2

## RWS/SiRF Session Tu1B

### RF FRONTEND TECHNOLOGIES

**Chair: Jan Budroweit**

**Co-Chair: Václav Valenta**

Room: Melrose 3

## SiRF Session Tu1C

### SEMICONDUCTOR DEVICE TECHNOLOGIES AND INTEGRATION

**Chair: Rob Schmid**

**Co-Chair: Mehmet Kaynak**

Room: Melrose 4

**8:00-9:40 AM**

**Tu1A-1**

**A ROM-Less DDS with Single Current-Switch Array Using Self-Adjusting Two-Step Integrator**

*Authors: Haruki Shibue, Ritsumeikan University; Hideyuki Nosaka, Ritsumeikan University*

**Tu1A-2**

**Dynamic Filtering with Time-Varying Transmission Lines**

*Authors: Sean Chen, University of California, Los Angeles; Yuanxun Ethan Wang, University of California, Los Angeles*

**Tu1A-3**

**A mmWave Transformer Based VCO-Divider for wideband Frequency Synthesizers in 22nm FDSOI**

*Authors: NAZMUS SAQUIB, Rensselaer Polytechnic Institute; Ahmed Elmenshawi, Rensselaer Polytechnic Institute; Mona Hella, Rensselaer Polytechnic Institute*

**Tu1A-4**

**A Signal Generator and Down-Conversion Mixer - TIA Unit for a 5.8-GHz FMCW Receiver in 65nm CMOS**

*Authors: Navid Naseh, Texas A&ampM University; Mohammad Ghaedi Bardeh, Texas A&ampM University; Kamran Entesari, Texas A&ampM University*

**Tu1A-5**

**A Compact Circuit Model for Frequency-Selective Limiters with Strong Field Nonuniformity**

*Authors: Qian Gao, University of California, Los Angeles; Yuanxun Ethan Wang, UCLA*

**Tu1B-1**

**Divide-by-4 Injection-Locked Frequency Divider Using Dual Linear Mixer Technique**

*Authors: Yo-Sheng Lin, National Chi Nan University; Chung-Ta Huang, National Chi Nan University; Yu-Cian Peng, National Chi Nan University*

**Tu1B-2**

**E-Band Active Upconverter Module with Tunable LO Feedthrough**

*Authors: Benjamin Schoch, University of Stuttgart; Dominik Wrana, University of Stuttgart; Laura Manoliu, Universität Stuttgart; Michael Kuri, Fraunhofer Institute for Applied Solid State Physics; Sandrine Wagner, Fraunhofer Institute for Applied Solid State Physics; Axel Tessmann, Fraunhofer Institute for Applied Solid State Physics; Ingmar Kallfass, University of Stuttgart*

**Tu1B-3**

**Digital Front End Transceiver Technology for Wireless Infrastructure**

*Authors: Kevin Chuang, Analog Devices, Inc.; Hossein Yektaii, Analog Devices, Inc.; Claire Masterson, Analog Devices, Inc.; Chris Mayer, Analog Devices, Inc.*

**Tu1B-4**

**Vector Modulator Based Leakage Cancellation Technique for CW Radar Transceiver Frontends**

*Authors: Batuhan Sutbas, IHP Microelectronics; Mohamed H Eissa, IHP Microelectronics; Gerhard Kahmen, IHP Microelectronics*

**Tu1B-5**

**HBT Power Detector utilizing an Ultra-compact Transformer-based Coupler for 5G BIST**

*Authors: Enrico Jimenez Tuero, IHP Microelectronics; Aniello Franzese, IHP GmbH; Andrea Malignaggi, IHP Microelectronics*

**Tu1C-1**

**Enabling next generation wireless and wireline communications with RF foundry technology**

*Authors: Roda Kanawati, Tower Partners Semiconductor Company; Kurt Moen, Tower Partners Semiconductor Company; Ed Preisler, Tower Partners Semiconductor Company; Hidetoshi Kawasaki, Tower Partners Semiconductor Company; Stan Phillips, Tower Partners Semiconductor Company; Allan Calvo, Tower Partners Semiconductor Company; Rula Badarneh, Tower Partners Semiconductor Company; Lina Guo, Tower Partners Semiconductor Company; Samir Chaudhry, Tower Partners Semiconductor Company; Marco Racanelli, Tower Partners Semiconductor Company*

**Tu1C-2**

**Heterogenous integration Technologies**

*Author: Subramanian Iyer, University of California, Los Angeles*

**Tu1C-3**

**Performance Trade-Off of RFSOI Switches Under Scaled Bias Conditions**

*Authors: Siddhartha Dhar, STMicroelectronics; Stephane Monfray, STMicroelectronics; Frederic Gianesello, STMicroelectronics; Franck Julien, STMicroelectronics; Julien Dura, STMicroelectronics; Charles-Alex Legrand, STMicroelectronics; Julien Amouroux, STMicroelectronics; Bernadette Gros, STMicroelectronics; Loic Welter, STMicroelectronics; Clement Charbuillet, STMicroelectronics; Philippe Cathelin, STMicroelectronics; Elodie Canderle, STMicroelectronics; Nathalie Vulliet, STMicroelectronics; Emmanuel Escolier, STMicroelectronics; Lucas Antunes, STMicroelectronics; Eric Rouchouze, STMicroelectronics; Pascal Fornara, STMicroelectronics; Christian Rivero, STMicroelectronics; Guillaume Bertrand, STMicroelectronics; Pascal Chevalier, STMicroelectronics; Arnaud Regnier, STMicroelectronics; Daniel Gloria, STMicroelectronics; Alain Fleury, STMicroelectronics; Siddhartha Dhar, STMicroelectronics; Siddhartha Dhar, STMicroelectronics*

# Joint RWW/ARFTG Plenary Session

**10:10 AM – 12:00 PM**

## Microwave Acoustic Filters for Wireless Communications: Recent Developments and Innovations

***Amelie Hagelauer***
*Professor at Technical University Munich, Co-Director of the Fraunhofer Research Institution for Microsystems and Solid-State Technologies*

For 30 years the success of microwave acoustics, mainly in mobile phones, has been unstoppable. A lot of effort has been spent to reduce the number of SAW/BAW devices, or ideally, completely remove them. However, no competitive technology providing the same performance at the same size and cost exists today. Thus, the trend is going in the opposite direction, driven by the demand for ever higher data rates and the desire to use the same phone in all parts of the world. The number of acoustic wave devices in a mobile phone is increasing with each new generation of communication standards. In this talk recent developments and innovations for microwave acoustic filters are presented. Those developments are novel architectures, new materials and advanced modeling techniques.

Prof. Amelie Hagelauer received the Dipl.-Ing. degree in mechatronics and the Dr.-Ing. degree in electrical engineering from Friedrich-Alexander-University Erlangen-Nuremberg, Erlangen, Germany, in 2007 and 2013, respectively. In November 2007, she joined the FAU Institute for Electronics Engineering, where she researched on BAW resonators and filters toward her Ph.D. degree. Since 2013, she has been focusing on SAW/BAW and RF MEMS components, as well as on microwave integrated circuits for frontends. From 2016 to 2019, she had been leading a Research Group on electronic circuits and from August 2019 to September 2021 she was Full Professor at the University of Bayreuth, Germany. In September 2021, she has joined the Technical University Munich as Full Professor and became the Co-Director of the Fraunhofer Research Institution for Microsystems and Solid State Technologies EMFT. She has been engaged in research and development of microwave theory and technology, electronic circuits and systems, and communication and sensing systems. In these fields, she has authored or coauthored more than 140 peer-reviewed publications. She acted as a Guest Editor for a special issue of the IEEE Transactions on Microwave Theory and Techniques on the topic RF Frontends for Mobile Radio and is now an Associate Editor of the IEEE Transactions on Microwave Theory and Techniques.

## Future trends in RF and wireless test capabilities from 5G to 6G and beyond

***Charles Schroeder***
*NI Fellow (NI)*

Measurements, and the science behind them, are key to the design of modern electromechanical systems. And while the devices we're designing are evolving rapidly, the instruments making these key measurements of performance have been slower to evolve. In general, the size of the instruments we all use hasn't changed in decades. And the internal architectures, still heavily reliant on PC-based hardware and software components, have reached their limits. It's time for a re-thinking, not just of the hardware and software architectures of instrumentation, but of how instruments are used as a part of the design process.

As an NI Fellow, Charles Schroeder works across the company on key business and technology-driven initiatives. He consults with executive leaders and department heads, including those from marketing, sales, and R&D, to drive the company's strategic direction, development, and future growth. With a focus on long-term innovation best practices and processes, he currently leads NI's efforts to find ground-breaking solutions to the test challenges introduced by the adoption of 6G and next generation wireless technologies.

Since joining NI in 1995, Charles Schroeder has held various positions, including vice president of product marketing for RF and wireless communications and leadership roles across the RF, modular instruments, DAQ, and IMAQ Vision product lines. He holds bachelor's and master's degrees in electrical engineering from Texas A&M University.

## SHORT COURSE

Room: Melrose 3

**1:30 – 2:30 PM**

### Power Amplifier Characterization/ Automation for Digital Predistortion (DPD) Metrics and Algorithm Validations

*Lecturer: Anis Ben Arfi, Analog Devices*

The imminent deployment of 5G networks combined with challenging technical specifications requires new and agile methods to optimize and validate the RF solutions. Particularly, developers of 5G RF Power Amplifiers (PAs) and front-end module technology often face difficult trade-off between device linearity and efficiency. To address the increased bandwidth and power efficiency requirements of 5G systems, today's Small Cell and MIMO PAs are pushed to operate at non-linear regions. Hence, the need for Digital Pre-Distortion (DPD) to correct for the non-linearity and preserve the highly-efficient PA operation. The design of these efficient PAs needs to follow critical criteria to ensure linearizability (i.e the PA's ability to be linearized by applying predistortion). For this reason, at ADI, we perform a thorough PA characterization to verify the aforementioned criteria. However, PA characterization is a delicate and lengthy routine which needs to be automated. In fact, we are looking to evaluate significant number of PAs provided by ADI costumers and partner PA vendors. The PA characterization's main purpose is to ensure that ADI DPD algorithms can handle the large set of PAs used by our customers. With the increasing number of new PAs to be tested, an automation of the PA characterization process becomes necessary in order to perform this characterization in shorter time periods.

The first part of this short course, will lay the foundation of the PA behavior and the DPD metrics used to evaluate its linearizability. Afterwards, the PA characterization process will be presented along with examples of PA reports provided by ADI to customers.

The second part of the short course will touch on the automated test-bench solution developed to perform power and frequency sweeps. The setup was developed using LabView to automate the test equipment and perform RF pulsed and modulated measurements. Similarly, the KeySight PNA-X automation work will be introduced. The PNA-X is used to measure the PA gain flatness over frequency, AM/AM, AM/PM and two-tone response. Finally, the short course will showcase the performance obtained using ADI transceiver boards linearizing various PAs and will discuss the best practices to obtain accurate results.

## SIRF Session Tu2C

## MILLIMETER-WAVE AND SUB-TERAHERTZ CIRCUITS

**Chair: Chris Coen**

**Co-Chair: Alexander Haag**

Room: Melrose 4

**1:30 – 3:10 PM**

**Tu2C-1**

### Scaling of on-chip CMOS radiating arrays above 200 GHz

*Author: Eran Socher, Tel-Aviv University*

**Tu2C-2**

### An Active Reflection Phase Shifter with High Gain for Reconfigurable Reflectarrays above 0.24 THz

*Authors: Ekaterina Kunakovskaya, Karlsruhe Institute of Technology; Cagri Ulusoy, Karlsruhe Institute of Technology*

**Tu2C-3**

### A Differential SiGe HBT Doherty Power Amplifier for Automotive Radar at 79 GHz

*Authors: Jan Schoepfel, Ruhr University Bochum; Holger Rücker, IHP GmbH; Nils Pohl, Ruhr University Bochum*

**Tu2C-4**

### Thermal Analysis and Design of a Ka-Band Power Amplifier in 130 nm SiGe BiCMOS

*Authors: Alexander Haag, Karlsruhe Institute of Technology; Mehmet Kaynak, IHP Microelectronics; Ahmet Cagri Ulusoy, Karlsruhe Institute of Technology*

## Session Tu2D

## INTERACTIVE FORUM POSTER SESSION

Room: Celebrity Ballroom

**1:30 – 3:10 PM**

**Tu1**

### A Planar V-Band Antenna for Wideband Radar and Communication on Low-Cost PCB Substrate

*Authors: Sebastian Peters, Friedrich-Alexander-Universität Erlangen-Nürnberg; Samira Faghih-Naini, Friedrich-Alexander-Universität Erlangen-Nürnberg; Stefan Erhardt, Friedrich-Alexander-Universität Erlangen-Nürnberg; Torsten Reissland, University of Erlangen-Nuremberg; Robert Weigel, Friedrich-Alexander-Universität Erlangen-Nürnberg*

**Tu2**

### An RFID sensing method based on magnetic control antenna coupling

*Authors: Yang Pan, Zhejiang University; Xingyu Liu, Zhejiang University; Yuting Wu, Zhejiang University; Peiying Lin, Zhejiang University; Zhouyi Wu, Zhejiang University; jiangtao huangfu, Zhejiang University*

**Tu3**

### A Wideband Dual-Polarized Antenna Designed for Antenna-in-Package (AiP)

*Authors: Wei-Lun Hsu, National Chung Cheng University; Yuan-Chun Lin, National Chung Cheng University; Kuo-Hung Cheng, National Chung Cheng University; Shih-Cheng Lin, National Chung Cheng University; Chia-Chan Chang, National Chung Cheng University; Sheng-Fuh Chang, National Chung Cheng University*

**Tu4**

### Consideration of Nonlinear Effects in Different Receiver Architectures for Use in Passive Radar Systems

*Authors: Marie Horlbeck, Friedrich-Alexander-Universität Erlangen-Nürnberg; Benedict Scheiner, Friedrich-Alexander-Universität Erlangen-Nürnberg; Robert Weigel, Friedrich-Alexan, Hamburg University of Technology*

**Tu5**

### Indoor Wireless Localization of UncooperativeSources Using a Ray Tracing Model

*Authors: Richard T Clark, Pacific Northwest National Laboratory; Andrew W Engel, Pacific Northwest National Laboratory; Trey E Shenk, Pacific Northwest National Laboratory; David M Sheen, Pacific Northwest National Laboratory*

**Tu6**

### A High-Linearity 10-GHz-ERBW 3-to-7-GS-s Voltage-to-Time Converter with Built-In S-H

*Authors: Lachlan Cuskelly, University of Calgary; Dhruv Bhaskar, University of Calgary; Leonid Belostotski, University of Calgary*

**Tu7**

### Study of High Frequency Nonlinear Memory Effect on Doherty Power Amplifiers Linearization Performances for 5G Applications

*Authors: Christophe Quindroit, Ampleon; Pablo Rochas, Ampleon; Nelsy Monsauret, Ampleon; Alexis Courty, Ampleon*

**Tu8**

### Driver's vital-signs monitoring with a single 60GHz sensor

*Author: Ryota Kawasaki, University of Kitakyushu*

**Tu9**

### Dual-Core mm-Wave VCO with Enhanced Second Harmonic Extraction by Mode Separation

*Authors: Meghana Kadam, Technische Universität Braunschweig; Fabio Padovan, Infineon Technologies AG; Vadim Issakov, Technische Universität Braunschweig*

**TU10**

### A Hybrid Technique to Increase Throughput of the Streaming Spectrum Sensor

*Author: Dylan J Gormley, National Aeronautics and Space Administration*

**Tu11**

### Compact Half-Mode Triple-Band Bandpass Filter by using Stepped Impedance Resonators with Grounding Via Holes

*Authors: Ceyhun Karpuz, Pamukkale University; Pınar Ozturk Ozdemir, Air Force Academy National Defence University; Hasan H Balık, Yildiz Technical University; Adnan Gorur, Nigde Omer Halisdemir Univ*

**Tu12**

### Substrate Integrated Waveguide Balun Bandpass Filter with Controllable Transmission Zeros for C Band Application

*Authors: Ceyhun Karpuz, Pamukkale University; Gulfem Balasu Fırat Unuk, Pamukkale University; Pınar Ozturk Ozdemir, Air Force Academy National Defence University; Ali Kursad Gorur, Nevsehir Haci Bektas Veli University*

**Tu13**

### Compact Wilkinson Power Dividers Based on Narrow Slits Loaded Transmission Lines

*Authors: Ceyhun Karpuz, Pamukkale University; Ali Kursad Gorur, Nevsehir Haci Bektas Veli University; Mehmet Cakir, Pamukkale University; Adnan Gorur, Nigde Omer Halisdemir Univ*

## RWS Session Tu3A

### FILTERS AND POWER DIVIDERS

**Chair: Roberto Gomez-Garcia**

**Co-Chair: Changzhi Li**

Room: Melrose 1 & 2

## RWS Session Tu3B

### WIRELESS COMMUNICATION SYSTEMS

**Chair: Jasmin Grosinger**

**Co-Chair: Mario Pauli**

Room: Melrose 3

## SiRF Session Tu3C

### INTEGRATED PHOTONICS AND PHOTONIC ELECTRONIC CIRCUITS

**Chair: Rob Schmid**

**Co-Chair: Saeed Zeinolabedinzadeh**

Room: Melrose 4

**3:40-5:20 PM**

**Tu3A-1**

**The Anglet: An E-H-plane Bent, 90-Degree Twisted, TE101-TM110-Mode Singlet Building Block**

*Authors: Chad Bartlett, University of Kiel; Michael Höft, University of Kiel*

**Tu3A-2**

**Design and Characterization of Bandpass Filter with Multiple Zeros on Glass Interposer for 6G Applications**

*Authors: Xingchen Li, Georgia Institute of Technology; Xiaofan Jia, Georgia Institute of Technology; Serhat Erdogan, Georgia Institute of Technology; Madhavan Swaminathan, Georgia Institute of Technology*

**Tu3A-3**

**A Compact Reconfigurable Filtering PIN Diode Switch Based on Hybrid Resonator Topology**

*Authors: Behrooz Rezaee, Graz University of Technology; Hossein Sarbandi Farahani, Graz University of Technology; Wolfgang Bösch, IHF- TU Graz*

**Tu3A-4**

**A Full Ka-Band Low-Loss and Monolithically 3-D Printed Dual-Polarized Waveguide Power Divider Based on Shaped Double-Ridged Bøifot Junction**

*Authors: Zhihong Xu, Shenzhen University; Jin Li, Shenzhen University; Tao Yuan, Shenzhen University*

**Tu3A-5**

**A mm-wave RC PPF Quadrature Network with Gain Boosting in 22nm CMOS FDSOI**

*Authors: Mohammad Ghaedi Bardeh, Texas A&M University; Navid Naseh, Texas A&ampM University; Jierui Fu, Texas A&M University; Jeyanandh Paramesh, Texas A&M University; Kamran Entesari, Texas A&M University*

**Tu3B-1**

**Design and Analysis of a RF Front-End Receiver System Based on Multi-Layer Organic Filtering for Sub-6GHz Mobile Communication Applications**

*Authors: Armin Schuster, Friedrich-Alexander-Universität Erlangen-Nürnberg; Stefan Erhardt, Friedrich-Alexander-Universität Erlangen-Nürnberg; Torsten Reissland, Friedrich-Alexander-Universität Erlangen-Nürnberg; Robert Weigel, Friedrich-Alexander-Universität Erlangen-Nürnberg*

**Tu3B-2**

**Improving Coding Efficiency in All-digital Transmitters**

*Authors: Samuel S Pereira, Universidade de Aveiro; Luís F Almeida, University of Aveiro; Arnaldo R Oliveira, University of Aveiro; Nuno Carvalho, University of Aveiro; Paulo Monteiro, University of Aveiro*

**Tu3B-3**

**Transceiver Setup for Joint Communication and Sensing Applications in V-Band**

*Authors: Samira Faghih-Naini, Friedrich-Alexander-Universität Erlangen-Nürnberg; Sebastian Peters, Friedrich-Alexander-Universität Erlangen-Nürnberg; Thomas Kurin, Friedrich-Alexander-Universität Erlangen-Nürnberg; Stefan Erhardt, Friedrich-Alexander-Universität Erlangen-Nürnberg; Torsten Reissland, University of Erlangen-Nuremberg; Robert Weigel, Friedrich-Alexander-Universität Erlangen-Nürnberg*

**Tu3B-4**

**True Time Delay-based Alignment for All-digital Beamforming Transmitters**

*Authors: Luís Filipe Almeida, University of Aveiro; Samuel S Pereira, University of Aveiro; Ivo Rodrigues, University of Aveiro; Ricardo Correia, University of Aveiro; Miguel Drummond, University of Aveiro; Arnaldo R Oliveira, University of Aveiro; Nuno Carvalho, University of Aveiro*

**Tu3C-1**

**Monolithically Integrated Optoelectronic Transmitter based on Segmented Mach-Zehnder Modulator in EPIC 250 nm BiCMOS Technology**

*Authors: Festim Iseini, IHP Microelectronics; Mesut Inac, IHP Microelectronics; Andrea Malignaggi, IHP Microelectronics; Anna Peczek, IHP Microelectronics; Gerhard Kahmen, IHP Microelectronics*

**Tu3C-2**

**Automatic Tuning of Microwave Silicon Photonic Ring Resonators**

*Authors: Ramy Rady, Texas A&M University; Christi K Madsen, Texas A&M University; Samuel Palermo, Texas A&M University; Kamran Entesari, Texas A&M Univ.*

**Tu3C-3**

**Tunable and Highly Power Efficient Traveling Wave Amplifier in SiGe BiCMOS for Optical Modulators**

*Authors: Mesut Inac, IHP Microelectronics; Falk Korndoerfer, IHP Microelectronics; Friedel Gerfers, Technische Universitat Berlin; Andrea Malignaggi, IHP Microelectronics*

# Tuesday, 24 January 2023

**5:30-7:30 PM**

## MTT-S Space Night

**Organizers: Markus Gardill, Brandeburg University of Technology**

**Marie Piasecki, NASA Glenn Research Center**

**Václav Valenta, from European Space Agency**

**Room: Melrose 3**

## SHaRC Keynote Presentation

### Next Generation Connectivity from LEO to Lunar

**Erik Luther,** *VP of Product, CesiumAstro*

Driven by a passion for connecting people and technology, Erik Luther has spent his career bringing tools and technologies to market that enable step changes in innovation. During his time with NI (National Instruments) and Ettus Research, Luther focused on wireless communications, building software-defined radio platforms demonstrating the first 5G technologies, including Massive MIMO, 5G mmWave, and DARPA's Colosseum testbed. As a co-owner of X-Microwave, he pioneered new approaches to RF and microwave system design. Recognizing space as connectivity's next frontier, Luther joined CesiumAstro in 2020 as vice president of product, marketing, and sales, building next-generation communications systems for high-performance airborne, space, and cislunar missions. Luther holds a bachelor's degree in electrical engineering from the University of Missouri.

**Presentation Abstract:**

With hundreds of commercial rocket launches delivering thousands of payloads to orbit scheduled over the next several years, space has never been more accessible. These missions represent the dawn of a new era of commercial, civil, and defense applications from LEO to cislunar and beyond. RF and microwave systems serve critical roles in every mission, in some cases as the primary payload for communications services or sensing, and in others, providing communication and localization support. Soon, 5G NTN and 6G will blend terrestrial networks and satellite infrastructure for Earth-based communication, NASA's Artemis program will return humans to the moon, and the U.S. Department of Defense's Space Development Agency (SDA) will deploy expanded space defense capabilities. These ambitious plans represent but three of hundreds of programs and business models that are now within reach. The exponential growth in users and missions will require more efficient antennas and RF electronics in addition to better use of radio spectrum. In this session, we discuss opportunities, challenges, and the need for innovation to enable the next generation of space capabilities.

## PANEL SESSION

### BEAMFORMING SOLUTIONS FOR TERRESTRIAL AND SPACE APPLICATIONS

***(part of SHaRC Space Night event)***

**Organizer: Václav Valenta from European Space Agency**

**Room: Melrose 3**

More than 110 year ago, the very first phased array with beam-steering capability was introduced by K. F. Braun during his Nobel prize lecture. This concept has given basis to many communication and radar system. Although we've gained vast, over a century long experience in developments of phased-arrays, large-volume and economically viable commercial solutions started to emerge only during the last decade. The latter has been enabled through maturing and affordability of silicon technologies, advances in packaging, making commercial phased arrays available to anyone.

Today, multibeam active antennas play the key role in many modern terrestrial and SATCOM systems, allowing for high throughput, flexibility and connectivity worldwide.

Recognised experts and scientists from both academia and industry worldwide have been invited to join this panel. Capabilities of today's beamforming solutions will be discussed together with challenges and trends in beamforming for 5G, terrestrial and spaceborne SATCOM.

**Panellists**

- **Siriram Muralidharan**, *RF Design Engineering manager at Analog Devices*
- **Ryan Jennings,** *Vice president of SATCOM and system engineer at Anokiwave*
- **Tumay Kanar,** *Senior manager for mm-wave IC design and product marketing at Renesas*
- **Jose Luis Flores,** *Microwave and RF design engineer at Celestia UK*
- **Erik Luther,** *VP of Product, CesiumAstro*

## RWS Session We1A

### ADVANCED PASSIVE COMPONENTS AND PACKAGING METHODS

**Chair: Charlie Jackson**

**Co-Chair: Robert Caverly**

Room: Melrose 1 & 2

## WisNet Session We1B

### RF-MILLIMETER-WAVE SENSING SYSTEMS

**Chair: Wooyeol Choi**

**Co-Chair: Paolo Mezzanotte**

Room: Melrose 3

## SHaRC Session We1C

### SYSTEMS, HARDWARE, AND ELECTRONICS FOR SPACE

**Chair: Markus Gardill**

**Co-Chair: Marie Piasecki**

Room: Melrose 4

**8:00-9:40 AM**

**We1A-1**

**A Power-Efficient Compact Ku-Band System-on-Antenna Module with Chip-First Package Integration**

*Authors: Xenofon Konstanti, Michigan State University; John D Albrecht, Michigan State University; Premjeet Chahal, Michigan State University; John Papapolymerou, Michigan State University*

**We1A-2**

**Chip-embedded Glass Interposer for 5G Applications**

*Authors: Xingchen Li, Georgia Institute of Technology; Xiaofan Jia, Georgia Institute of Technology; Kyoung-sik Moon, Georgia Institute of Technology; Joon Woo Kim, Georgia Institute of Technology; Aadit Pandey, Georgia Institute of Technology; Anthony Chiu, QORVO, Inc.; Andrew A Ketterson, QORVO, Inc.; Madhavan Swaminathan, Georgia Institute of Technology*

**We1A-3**

**Patterned Multi-Material Die Attach Process Using Aerosol-Jet Printing**

*Authors: Wesley Spain, Michigan State University; John Papapolymerou, Michigan State University; Prem Chahal, Michigan State University; John Albrecht, Michigan State University*

**We1A-4**

**3D Printed Acoustical Hybrid and Applications Based on the Microwave Case**

*Author: Charles Jackson, 3DA&ampM LLC*

**We1B-1**

**2D Imaging of a Drone Using a Millimeter-Wave Fast Chirp MIMO Radar Based on Khatri-Rao Product Virtual Array Processing**

*Authors: Kenshi Ogawa, National Defense Academy of Japan; Masashi Kurosaki, National Defense Academy of Japan; Ryohei Nakamura, National Defense Academy of Japan; Hisaya Hadama, National Defense Academy of Japan*

**We1B-2**

**24-GHz Frequency Scanning Doppler Vibrometer**

*Authors:: Giordano Cicioni, University of Perugia; Raffaele Salvati, University of Perugia; Roberto Vincenti Gatti, University of Perugia; Valentina Palazzi, University of Perugia; Paolo Mezzanotte, University of Perugia; Luca Roselli, University of Perugia; Federico Alimenti, University of Perugia*

**We1B-3**

**2-Way Localization of RFID Tags**

*Authors: Jasmin Walk, University of Innsbruck; Thomas Ussmueller, University of Innsbruck*

**We1B-4**

**318-EA338**

**Violin Gesture Recognition Using FMCW Radars**

*Authors: Hannah Y Gao, Texas Tech University; Christopher Williams, Texas Tech University; Victor G Rizzi Varela, Texas Tech University; Changzhi Li, Texas Tech University*

**We1B-5**

**Experimental Study on Multiple Drone Detection Using a Millimeter-wave Fast Chirp MIMO Radar**

*Authors: Masashi Kurosaki, National Defense Academy of Japan; Kenshi Ogawa, National Defense Academy of Japan; Ryohei Nakamura, National Defense Academy of Japan; Keiji Jimi, Gunma University; Hisaya Hadama, National Defense Academy of Japan*

**We1C-1**

**Low-Noise Block Downconverter based on COTS and SIW Filters for Ku-band Cubesat Transponders**

*Authors: Giulia Orecchini, University of Perugia; Giacomo Schiavolini, University of Perugia; Paolo Mezzanotte, University of Perugia; Simone Pauletto, Picosats s.r.l.; Andrea Loppi, Picosats s.r.l; Andrea Beltramello, Picosats s.r.l.; Federico Dogo, Picosats s.r.l.; Davide Manià, Picosats s.r.l.; Valentina Palazzi, University of Perugia; Guendalina Simoncini, University of Perugia; Luca Roselli, University of Perugia; Anna Gregorio, Picosats s.r.l.; Mario Fragiacomo, Picosats s.r.l.; Federico Alimenti, University of Perugia*

**We1C-2**

**Demonstration of a Switched Wideband GaN High-Power Amplifier for Future Space Missions**

*Authors: Rainee N Simons, NASA Glenn Research Center; Joseph A Downey, NASA Glenn; Bryan L Schoenholz, NASA Glenn; Marie Piasecki, NASA; Nang T Pham, NASA Glenn Research Center; Mansoor K Siddiqui, Northrop Grumman Corporation; Ralph G Bonnin, Northrop Grumman Aerospace Systems*

**We1C-3**

**Versatile Linearized Miniature TWTAs for Phased Arrays in Space**

*Authors: Allen Katz, The College of New Jersey; Roger Dorval, Linear Space Technology; Robert Gray, Linear Space Technology; Christopher H Tenev, Linear Space Technology*

**We1C-4**

**A Highly Integrated and Software-Controlled L to Ka-Band Front-End for SDRs in space applications**

*Authors: Jan Budroweit, DLR; Felix Eichstaedt, German Aerospace Center; Ferdinand Stehle, DLR e.V.*

**We1C-5**

**Towards Wireless Ranging and Synchronization using CubeSat Software-Defined Radio Subsystems**

*Authors: Markus Gardill, Brandenburg University of Technology; Dominik Pearson, Center for Telematics; Julian Scharnagl, Center for Telematics; Klaus Schilling, Zentrum für Telematik*

# Wednesday, 25 January 2023

## RWS Session We2A

### WIDEBAND & TUNABLE mmWAVE ANTENNAS

**Chair: Jeremy Muldavin**

**Co-Chair: Holger Maune**

Room: Melrose 1 & 2

## WisNET Session We2B

### WIRELESS SENSORS CIRCUITS & SYSTEM

**Chair: Thomas Ußmüller**

**Co-Chair: Rahul Khanna**

Room: Melrose 3

## SHaRC Session We2C

### MISSION CONCEPTS, OPERATIONS, REGULATIONS, AND STANDARDIZATION

**Chair: Jan Budroweit**

**Co-Chair: Charlie Jackson**

Room: Melrose 4

**10:10-11:50 AM**

**We2A-1**

**Compact and Broadband 300 GHz Three-Element On-Chip Patch Antenna**

*Authors: Tim Pfahler, Friedrich-Alexander-Universität Erlangen-Nürnberg; Martin Vossiek, Friedrich-Alexander-Universität Erlangen-Nürnberg; Jan Schür, Friedrich-Alexander-Universität Erlangen-Nürnberg*

**We2A-2**

**A Compact 3-D-Printing-Compatible Dual-Polarized Spherical Resonator Antenna With Improved Bandwidth and Reliability**

*Authors: Shuai Deng, Shenzhen University; Jin Li, Shenzhen University; Tao Yuan, Shenzhen University*

**We2A-3**

**An mmWave FZP-Based Phased Array**

*Authors: Qiangli Xi, Zhejiang University; Bin Zhang, Zhejiang University; Lixin Ran, Zhejiang University*

**We2A-4**

**Ultra-Wide Bandwidth Substrate Integrated Waveguide Fed Vivaldi Antenna in D-Band Using Glass Interposer**

*Authors: Lakshmi Narasimha Vijay Kumar, Georgia Institute of Technology; Madhavan Swaminathan, Georgia Institute of Technology*

**We2B-1**

**State-Recovery Protocol for URLLC Applications in 5G Systems**

*Authors: Anas Alsoliman, University of California, Irvine; Forough S Abkenar, University of California, Irvine; Marco Levorato, University of California, Irvine*

**We2B-2**

**A novel method for determining the degree of hydrogen loading of LOHC using cavity based permittivity measurements**

*Authors: Nico Weiss, Hamburg University of Technology; Alexander Koelpin, Hamburg University of Technology; Irina Wiemann, Friedrich-Alexander-Universität Erlangen-Nürnberg; Eberhard Schluecker, Friedrich-Alexander-Universität Erlangen-Nürnberg*

**We2B-3**

**An Energy Efficient LoRa-based Multi-Sensor IoT Network for Smart Agriculture System**

*Authors: Shivakant Mishra, University of Colorado; Sanjeet Nayak, IIITDM Kancheepuram; Ramnarayan Yadav, IIT-RAM, Ahmedabad*

**We2B-4**

**A Simple Low Jitter Wireless Triggering and Unidirectional Communication System**

*Authors: Andreas Depold, Friedrich-Alexander-Universität Erlangen-Nürnberg; Christian Dorn, Technical University of Munich; Robert Weigel, Friedrich-Alexander-Universität Erlangen-Nürnberg; Fabian Lurz, Hamburg University of Technology*

**We2B-5**

**A Wireless Lightweight System Node for Energy Efficient Beehive Sensing**

*Authors: Thomas Kurin, Friedrich-Alexander-Universität Erlangen-Nürnberg; Marie Horlbeck, Friedrich-Alexander-Universität Erlangen-Nürnberg; Timo Maiwald, Friedrich-Alexander-Universität Erlangen-Nürnberg; Robert Weigel, Friedrich-Alexander-Universität Erlangen-Nürnberg; Fabian Lurz, Hamburg University of Technology*

**We2C-1**

**A Digital Testbed for Autonomous Spacecraft Communication Services**

*Authors: Aaron Smith, National Aeronautics and Space Administration; Elmer W Brown, Case Western Reserve University; Francis Merat, Case Western Reserve University*

**We2C-2**

**Evaluating an HDL-based multi-channel ADS-B receiver on a highly integrated SDR platform for space application**

*Authors: Felix Eichstaedt, German Aerospace Center; Ferdinand Stehle, German Aerospace Center; Jan Budroweit, German Aerospace Center*

**We2C-3**

**Multi-Mission Operations at Technische Universität Berlin through the example of TUBIN**

*Authors: Julian Bartholomäus, Technische Universitat Berlin; Philipp Werner, Technische Universität Berlin; Enrico Stoll, Technische Universität Berlin*

**We2C-4**

**CubeSat Platform Integrated UHF-VHF Antennas**

*Authors: Yu-Jiun Ren, General Microwave Technologies; Chien-Hsun Chen, Electric Connector Technology*

## SHORT COURSE

Room: Melrose 1 & 2

1:30-2:30 PM

**Linearization of Power Amplifiers used in Radio Frequency (RF) Transmitters**

*Lecturer: R. Neil Braithwaite, Keysight Technologies*

This short course reviews techniques used to linearize nonlinear power amplifiers (PAs) used in wireless transmission. It begins with an overview of wireless communications including data throughput and the key components within a transmitter. The primary focus is on the power amplifier, which often behaves in a nonlinear fashion.

Compensation for PA nonlinearities, referred to as linearization, is covered in more detail. This includes the measurement of PA nonlinearities, models of nonlinearities (referred to as behavioral modelling), as well as digital and analog linearization. Digital predistortion is discussed along with estimator structures that make the compensation adaptive. Analog techniques reviewed include feedforward compensation and analog predistortion. Comparisons are made between the linearization approaches.

## WisNET Session We3B

## HARDWARE TECHNOLOGIES FOR RADAR SYSTEMS

**Chair: Timo Jaeschke**

**Co-Chair: Changzhi Li**

Room: Melrose 3

1:30-3:10 PM

**We3B-1**

**Full Polarimetric Antenna System for Automotive Radar**

*Authors: Alessandro Tinti, Huawei Technologies Duesseldorf GmbH; Simon Tejero Alfageme, Huawei Technologies Duesseldorf GmbH; Sergio Duque Biarge, Huawei Technologies Duesseldorf GmbH; Nils Pohl, Ruhr University Bochum*

**We3B-2**

**Wireless Passive Radar Sensing Based on Discrete LNA-Mixer Co-Optimization and Fast-Startup Baseband Amplifier**

*Authors: Aaron B Carman, Texas Tech University; Changzhi Li, Texas Tech University*

**We3B-3**

**Optimizing the Coupling Factor of a Tapped Delay Line for Analog Radar Target Simulation**

*Authors: Kai Braungardt, Karlsruhe Institute of Technology; Axel Diewald, Karlsruhe Institute of Technology; Benjamin Nuss, Karlsruhe Institute of Technology; Thomas Zwick, Karlsruhe Institute of Technology*

**We3B-4**

**A Dual-Purpose All Digital RF Transmitter with a Feed-Forward Efficiency Enhancement Scheme**

*Author: Bulent Sen, ASELSAN, INC.*

**We3B-5**

**Range Resolution Improvement in FMCW Radar Through VCO's Nonlinearity Compensation**

*Authors: Max A Vasconcelos, Texas Tech University; Prateek Nallabolu, Texas Tech University; Changzhi Li, Texas Tech University*

## YOUNG PROFESSIONALS EVENT

Room: Celebrity 5

1:00-4:00 PM

**Hands-on Workshop:**
**AI for Wireless/RF Communications**

**Organizers: Pushkar Kulkarni, Qualcomm and Mehernaz Savai, MathWorks**

**Speakers: Mehernaz Savai and Sekhar Sekharan, MathWorks**

AI is being applied in Wireless and RF to develop smarter ways to model physical layers, optimize performance of wireless systems and networks, and address new 6G design challenges.

In this hands-on workshop, you will learn how to apply principles of AI (machine learning, deep learning, domain-specific processing) to Wireless Communication workflows.

This interactive hands-on session will include the following:

- Familiarize yourself with AI tools in MATLAB (no prior knowledge of MATLAB is needed)
- Create and evaluate necessary components to succeed in AI modeling, by implementing an example of Modulation Classification
- Deep dive into a complete AI workflow using an example application for 5G Channel Estimation

The final segment of this workshop is a presentation where you will learn to apply deep learning techniques to RF system design. We will look at the design of the Digital Pre-distortion (DPD) of the transmitted signal. You will learn how to generate test signals, develop, train and test a neural network as a DPD.

## SHORT COURSE

Room: Melrose 1 & 2

3:30-4:30 PM

### Wave-Matter Interaction at Millimeter-Wave Frequencies

*Lecturer: Prof. Abbas Omar, University of Magdeburg, Germany*

Millimeter Wave mobile communication (5G and beyond) is associated with much lower radiation power and much shorter communication range. Millimeter Wavelengths suffer from very strong attenuation in water-rich substances limiting penetration into biological objects (e.g., human and animal bodies and plants) to just few tenths of a millimeter. Deeper inside the body the intensity is negligible making for greater safety compared to early mobile standards (3G and 4G). However, the safety of millimeter-wave radiation for 5G and beyond remains a public concern.

The physical concepts underlying the wave-matter interaction, particularly at millimeter-wave frequencies, are reviewed and discussed in this talk. Health hazard associated with electromagnetic wave exposures are then discussed. These can generally be categorized in ionizing and non-ionizing effects. Health impact of millimeter-wave exposures belong to the latter, and therefore can be either the direct increase in the body temperature or the indirect overloading of the biological processes responsible for the body thermal regulation.

Ionizing radiations are best described by quantizing the related electromagnetic field and dealing with the wave-matter interaction as collisions between highly localized photons and the material atoms, molecules, and/or chemical bonds. On the other hand, at wavelengths that are much larger than the atomic/molecular scale, a continuous spatial distribution of the electromagnetic wave is an adequate mathematical representation. The wave power-density is described by the Poynting vector, and the power transfer from the wave to the biological substances can be calculated with high precision using the concept of constitutive parameters (conductivity, permittivity, and permeability). These are macroscopic spectral quantities (moving spatial averages), which cannot account for special treatment of specific molecular-scale structures similar to that of, e.g., DNA strand. Millimeter Waves and even Tera-Hertz Waves belong to this category.

## WisNET Session We4B

## RADAR SYSTEMS & SOFTWARE DEFINED RADIOS

**Chair: Václav Valenta**

**Co-Chair: Markus Gardill**

Room: Melrose 3

3:40-5:20 PM

**We4B-1**

### Low-cost Software-Defined Radio System with Deterministic RX to TX Delay Using Timestamps

*Authors: Christian Dorn, Technical University of Munich; Andreas Depold, Friedrich-Alexander-Universität Erlangen-Nürnberg; Fabian Lurz, Hamburg University of Technology; Amelie Hagelauer, Fraunhofer EMFT*

**We4B-2**

### Theoretical Limits and Interpolation based Improvements of a Correlation Based True-Speed-Over-Ground Estimation

*Authors: Torsten Reissland, University of Erlangen-Nuremberg; Robert Weigel, University Erlangen-Nuremberg; Alexander Koelpin, Hamburg University of Technology; Fabian Lurz, Hamburg University of Technology*

**We4B-3**

### Quality of service based radar resource management for synchronisation problems

*Authors: Tobias Müller, Fraunhofer FHR; Sebastian Durst, Fraunhofer FHR; Pascal Marquardt, Fraunhofer FHR; Stefan Brüggenwirth, Fraunhofer FHR*




# 100th ARFTG Microwave Measurement Symposium – Abbreviated Program

## 100th ARFTG Microwave Measurement Conference

MEASUREMENT CHALLENGES FOR EMERGING RF-TO-THZ TECHNOLOGIES

### Sunday, January 22nd

| | | |
|---|---|---|
| 7:00 am - 8:00 am | Continental Breakfast | Sunset 4 |
| 8:00 am - 5:00 pm | **ARFTG / NIST Short Course** | Sunset 5/6 |
| 9:45 am - 10:15 am | Break | |
| 12:00 pm - 1:00 pm | Short Course Lunch | Sunset 4 |
| 2:50 pm - 3:20 pm | Break | |

### Monday January 23rd

| | | |
|---|---|---|
| 7:00 am - 8:00 am | Continental Breakfast | Rotunda/Celebrity Ballroom Foyer |
| 8:00 am - 12:00 pm | **ARFTG / NIST Short Course** | **Sunset 5/6** |
| 9:00 am - 10:30 am | **NVNA Users Forum** | **Wilshire AB** |
| 9:40 am - 10:10 am | Break | Rotunda/Celebrity Ballroom Foyer |
| 10:30 am - 12:00 pm | **On-Wafer Users Forum** | **Wilshire A/B** |
| 11:30 pm - 1:30 pm | IEEE P1765 Meeting | Santa Monica 2 |
| 12:00 pm - 1:00 pm | Short Course Lunch | Sunset 4 |
| 1:00 pm – 1:10 pm | **ARFTG Conference Welcome** | **Celebrity 5** |
| 1:00 pm – 7:00 pm | RWW/ARFTG Exhibition | Celebrity Ballroom |
| 1:10 pm – 2:40 pm | **ARFTG Conference (Session I)** | **Celebrity 5** |
| 2:40 pm – 3:00 pm | **ARFTG Business Meeting** | **Celebrity 5** |
| 3:00 pm – 3:40 pm | Break – Exhibits | Celebrity Ballroom |
| 3:40 pm – 5:00 pm | **ARFTG Conference (Session II)** | **Celebrity 5** |
| 5:30 pm – 6:30 pm | **RWW/ARFTG Joint Reception** | **Celebrity Ballroom** |
| 6:30 pm – 7:30 pm | **PAWR/ARFTG Joint Panel** | **Celebrity 5** |
| 7:30 pm – 9:30 pm | **ARFTG Awards Dinner** | **Wilshire AB** |

### Tuesday January 24th

| | | |
|---|---|---|
| 7:00 am - 8:00 am | Continental Breakfast | Rotunda/Celebrity Ballroom Foyer |
| 8:00 am - 9:40 am | **ARFTG Conference (Session III)** | **Celebrity 5** |
| 8:00 am - 5:00 pm | RWW/ARFTG Exhibition | Celebrity Ballroom |
| 9:40 am – 10:10 am | Break – Exhibits | Celebrity Ballroom |
| 10:10 am – 12:00 pm | **RWW/ARFTG Joint Plenary (Session IV)** | **Celebrity 6-8** |
| 12:00 pm - 1:00 pm | Break for Lunch | |
| 1:00 pm - 3:00 pm | **ARFTG Conference (Session V)** | **Celebrity 5** |
| 1:30 pm - 3:40 pm | **RWW & ARFTG Interactive Forums** | **Celebrity Ballroom** |
| 3:00 pm - 3:40 pm | Break – Interactive Forum & Exhibits | Celebrity Ballroom |
| 3:40 pm - 5:00 pm | **ARFTG Conference (Session VI)** | **Celebrity 5** |
| 5:00 pm - 5:15 pm | **ARFTG Conference Close** | **Celebrity 5** |

### Wednesday January 25th

| | | |
|---|---|---|
| 7:00 am - 8:00 am | Continental Breakfast | Rotunda/Celebrity Ballroom Foyer |
| 8:00 am - 12:00 pm | **ARFTG Workshop** | **Celebrity 5** |
| 8:30 am - 10:00 am | IEEE P2822 Meeting | Wilshire AB |
| 9:40 am - 10:10 am | Break | Rotunda/Celebrity Ballroom Foyer |
| 9:30 am - 1:30 pm | IEEE P3136 Meeting | Sunset 5/6 |

# Industry Exhibits

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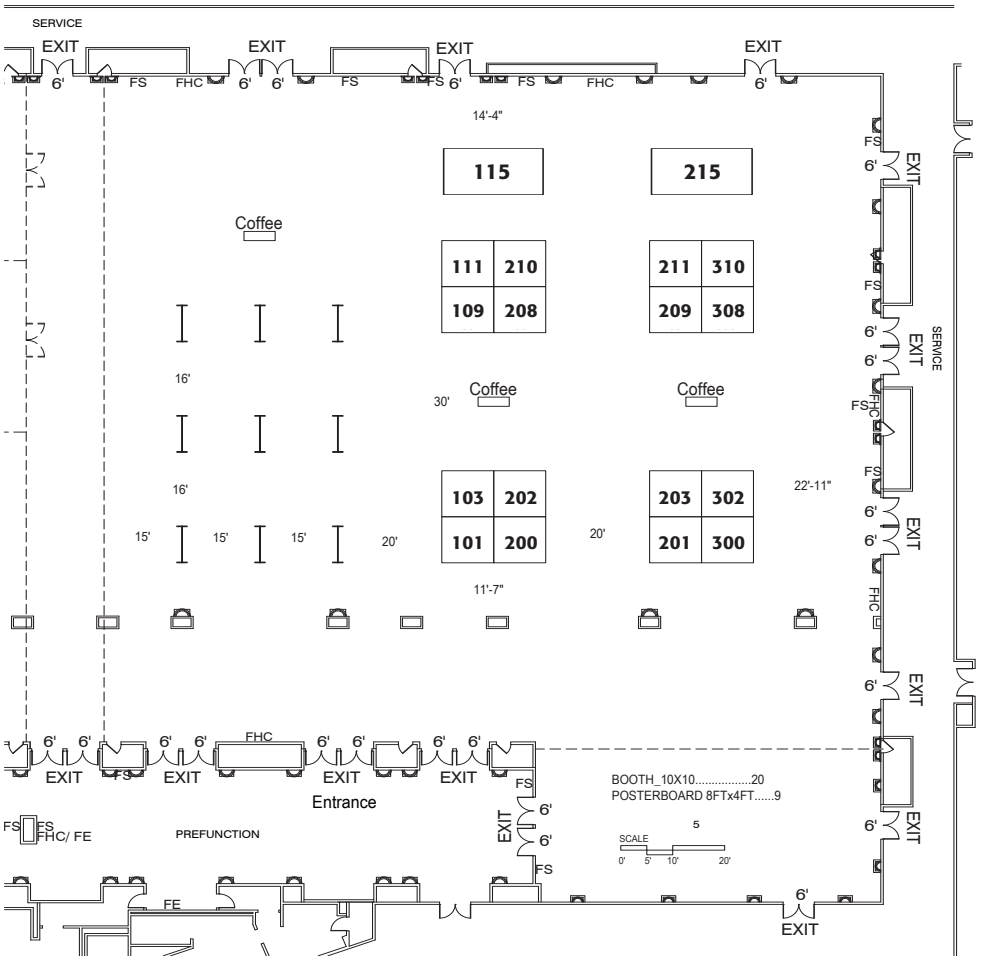
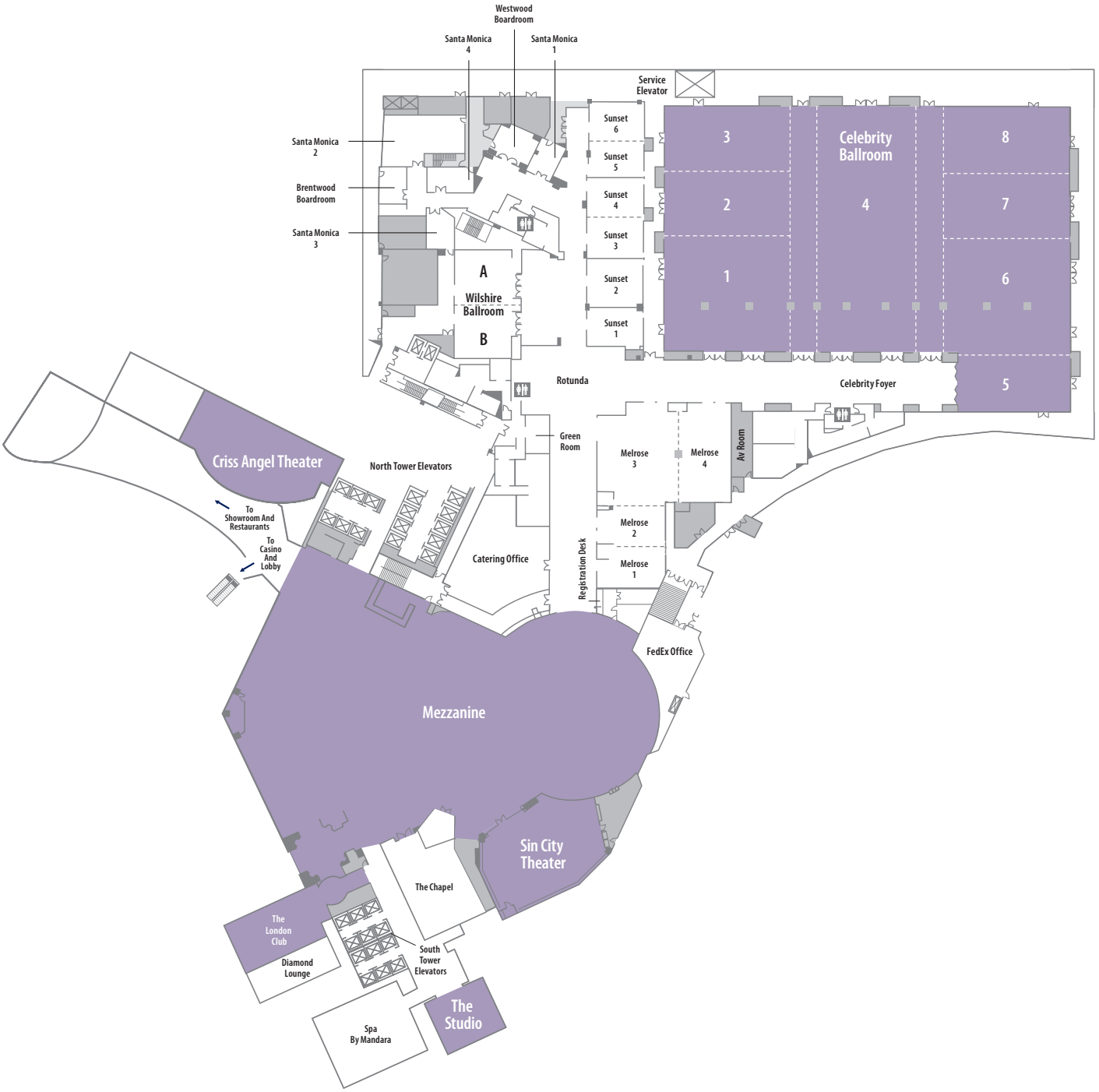
| EXHIBITORS | BOOTH # |
|---|---|
| Advanced Test Equipment Corp. | 101 |
| Anritsu | 115 |
| Berkeley Nucleonics Corporation | 310 |
| BroadWave Technologies, Inc. | 302 |
| Copper Mountain Technologies | 201 |
| Eravant | 203 |
| Junkosha, Inc. | 200 |
| Keysight Technologies | 111 |
| LMD LLC | 300 |
| Maury Microwave Corp. | 208 |
| Microsanj | 308 |
| Mitsubishi Electric US | 209 |
| MPI Corporation | 210 |
| Microwave Theory and Technology Society (MTT-S) | 215 |
| Rohde & Schwarz USA Inc. | 202 |
| SPINNER GmbH | 103 |
| TMY Technology Inc. | 211 |
| Virginia Diodes, Inc. | 109 |

## Room Celebrity Ballroom 4-8



# Hotel Map


Westwood Boardroom
Santa Monica 4
Santa Monica 1
Service Elevator
Santa Monica 2
Brentwood Boardroom
Santa Monica 3
Sunset 6
Sunset 5
Sunset 4
Sunset 3
Sunset 2
Sunset 1
3
2
1
Celebrity Ballroom
4
8
7
6
5
A
Wilshire Ballroom
B
Rotunda
Celebrity Foyer
Criss Angel Theater
North Tower Elevators
Green Room
Melrose 3
Melrose 4
Av Room
Melrose 2
Melrose 1
Registration Desk
To Showroom And Restaurants
To Casino And Lobby
Catering Office
FedEx Office
Mezzanine
Sin City Theater
The Chapel
The London Club
Diamond Lounge
South Tower Elevators
The Studio
Spa By Mandara