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Welcome to IMS2022 in Denver, Colorado. We are very excited about IMS coming to Denver and have planned a great event for you. We are planning an in-person event, a robust technical program, great social opportunities, and Denver is a wonderful place to visit. Several new innovations have been put into place that will make IMS2022 more informative and valuable for everyone. IMS2022 will be a great chance to re-establish connections and make new ones. Come explore the peaks of microwave engineering!

Downtown Denver is a vibrant community. The main hotels are less than six blocks from the Colorado Convention Center. There is a great mix of shops, restaurants and entertainment venues in the area near the Convention Center. Denver is known for having great weather—over 300 days of sunshine a year, and the Rocky Mountains are a short drive away.

The Systems Forum will be new in 2022. This will be a three-day forum that will bring together the latest in telecommunications, radar and space applications. There will be contributions from MTT-S Sister Societies, RFIC and ARFTG. There will be a theme to each main day of IMS. Tuesday is the Connected Future Summit (think 5G, 6G, ...) and Quantum Systems Day. Wednesday is Radar and Aerospace Day. Thursday is Phased Arrays and OTA Applications Day. During these days, look for additional Panel Sessions, more Focus Sessions, Technical Lectures, and Socials!

We are also working to increase industry participation in IMS. There will be opportunities for industry-based authors to showcase their work. There will also be opportunities for industry-based authors to mention companies supporting their work and show the company’s booth number if they are exhibiting. The trade show will be a great way to connect with suppliers and attendees alike. There are more than 440 companies exhibiting!

We are excited about being live and in-person in Denver. This will be a great opportunity for the microwave community to come together once again. This is also a great opportunity to showcase your work and learn about new technologies. We really look forward to seeing you in Denver in June 2022.

Ron Ginley
IMS2022 General Chair

Coffee Breaks

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<thead>
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<th>AM</th>
<th>PM</th>
<th>Location</th>
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<tbody>
<tr>
<td>Sunday</td>
<td>09:40-10:10</td>
<td>15:10-15:40</td>
<td>Grand Concourse</td>
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<td>Monday</td>
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<td>Grand Concourse</td>
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<td>IMS Show Floor</td>
</tr>
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<td>Thursday</td>
<td>09:40-10:10</td>
<td>15:10-15:40</td>
<td>IMS Show Floor</td>
</tr>
</tbody>
</table>

EXHIBITION HOURS

- Tuesday, 21 June 2022: 09:30–17:00
- Wednesday, 22 June 2022: 09:30–18:00
- Thursday, 23 June 2022: 09:30–15:00
Welcome to Denver, where 300 days of sunshine, a thriving cultural scene, diverse neighborhoods, and natural beauty combine for the world’s most spectacular playground. A young, active city at the base of the Colorado Rocky Mountains, Denver’s stunning architecture, award-winning dining and unparalleled views are all here, year-round.

Local boosters named the frontier mining camp on the South Platte River “Denver” after Kansas Territorial Governor James Denver in hopes of gaining political favor. Unfortunately, Denver had retired by the time they named the town. There were originally three separate towns, with three separate names, where Denver now stands. In 1859, the other names were dropped in return for a barrel of whiskey to be shared by all. Fittingly enough, the first permanent structure in Denver was a saloon.

By an amazing stroke of good luck, the 13th step on the west side of the Colorado State Capitol Building is exactly 5,280 feet above sea level—one mile high. In Denver’s rarified air, golf balls go 10 percent farther. So do cocktails. Alcoholic drinks pack more of a punch than at sea level. The Mile High City is also extremely dry, so it is a good idea to drink more water than usual. With less water vapor in the air at this altitude, the sky really is bluer in Colorado.

Denver is near the mountains, not in them. The Mile High City is located on high rolling plains, 12 miles east of the “foothills,” a series of gentle mountains that climb to 11,000 feet. Just beyond is the “Front Range of the Rocky Mountains,” a series of formidable snowcapped peaks that rise to 14,000 feet. Denver might not be in the mountains, but the mountains still dominate the city. The picturesque mountain panorama from Denver is 140 miles long. There are 200 visible named peaks including 32 that soar to 13,000 feet and above.

To plan your time in Denver and Colorado visit the ims-ieee.org.

High Altitude Tips!

**Denver Really Is Exactly One Mile High**
Denver really is a mile high, but most people don’t even notice the altitude difference. The air is just thinner and dryer. In fact, many people with respiratory problems move to Denver for the benefits of the dry air. Follow these tips to stay happy and healthy.

**Drink Water**
Before your trip to Denver, and while you are here, drinking plenty of water is the number one way to help your body adjust easily to our higher altitude. The low humidity in Colorado keeps the air dry, like the desert, so you need about twice as much water here as you would drink at home.

**Monitor Your Alcohol Intake**
In Denver’s rarified air, golf balls go ten percent farther... and so do cocktails. Alcoholic drinks pack more of a wallop than at sea level. It is recommended that you go easy on the alcohol in the mountains and in Denver, as its effects will feel stronger here.

**Eat Foods High In Potassium**
Foods such as broccoli, bananas, avocado, cantaloupe, celery, greens, bran, chocolate, granola, dates, dried fruit, potatoes and tomatoes will help you replenish electrolytes by balancing salt intake.

**Watch Your Physical Activity**
The effects of exercise are more intense here. If you normally run 10 miles a day at home, you might try 6 miles in Denver.

**Pack For Sun**
With less water vapor in the air at this altitude, the sky really is bluer in Colorado. But there’s 25 percent less protection from the sun, so sunscreen is a must. Denver receives more than 300 days of sunshine each year (more than San Diego or Miami). Bring sunglasses, sunscreen, lip balm... even in winter.

**Dress In Layers**
Two days before your trip to Denver, check the weather and use this information to pack appropriately. Because the sun is especially powerful in Denver, it can feel much warmer than the actual temperature during the daytime, but then become very chilly after sundown, particularly in the Spring and Fall. It is best to layer your clothing.

**Enjoy Yourself!**
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Justus Brevik, Interactive Forum Vice Co-Chair
Akim Babenko, Interactive Forum Co-Chair
Tom McKay, Demonstrations During Interactive Forum

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Jimmy Hester, Co-chair
Erin Kiley, Member
Daniel Tajik, Member
John Bandler, Senior Advisor

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Dennis Lewis, MicroApps
Janet O’Neil, MicroApps

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35,000 Square Foot Four Seasons Ballroom

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**GETTING AROUND AT IMS2022**

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100,000 Square Feet of Meeting Room Space

5,000-Fixed Seat Bellco Theatre

**BALLROOM LEVEL**
50,000 Square Foot Mile High Ballroom

35,000 Square Foot Four Seasons Ballroom

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**COLORADO CONVENTION CENTER**

**EXHIBIT LEVEL**

**STOUT STREET**

**WELTON STREET**

**14TH STREET (CITY VIEW)**

**SPEER BOULEVARD (MOUNTAIN VIEW)**

**EXHIBIT LEVEL**

**STOUT STREET**

**WELTON STREET**
<table>
<thead>
<tr>
<th>WORKSHOP TITLE</th>
<th>WORKSHOP ABSTRACT</th>
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<tbody>
<tr>
<td>Large-Scale Antenna Arrays: Circuits, Architectures, and Algorithms</td>
<td>Wireless networks have fueled socio-economic growth worldwide and are expected to further advance to enable new applications such as autonomous vehicles, virtual/augmented-reality, and smart cities. Due to shortage of sub-6GHz spectrum, mm-wave frequencies play an important role in the emerging 6G and the communication-on-the-move applications. Given that the propagation loss in the lower mm-wave band needs to be compensated by antenna array gain and densification of base stations with cell radius as small as a hundred meters, radio chipsets need to be power and cost efficient. To make radio chipsets power and cost efficient, state-of-the-art mm-wave-net transceivers are designed with phased antenna array (PAA). As a consequence, signal processing techniques and network protocols for mm-wave-nets are designed under constraints of PAA architectures. Future generations of mm-wave-nets will operate in the upper mm-wave frequency band where more than 10GHz bandwidth can be used to meet the ever-increasing demands. Their realization will demand addressing a completely new set of challenges including wider bandwidths, larger antenna array size, and higher cell density. These new system requirements demand fundamental rethinking of radio architectures, signal processing and networking protocols. Major breakthroughs are thus required in radio front-end architectures to enable coherent combining of wideband mm-wave spectrum, as most commonly adopted PAA-based radios face many challenges in achieving fast beam training, interference suppression, and wideband data communication. Through this workshop, we will look at the fundamental issue of coherent signal combination at these large scales from sub-GHz to sub-THz enabled by a diverse group of speakers with expertise spanning circuits, architecture, algorithms, and applications. The coherent combination will bring out true-time-delay array architectures including recent developments in wideband delay compensation methods with large range-to-resolution ratios. The delay compensation at different points of the receiver channel including RF, baseband, and digital will empower not only traditional wireless communications but also spatial signal processing for direction finding and interference suppression.</td>
</tr>
<tr>
<td>SWIPT — Simultaneous Wireless Information and Power Transmission for Future IoT Solutions</td>
<td>5G and future 6G wireless communications have an objective to massively deploy IoT sensors everywhere; this is important for smart cities, health sensors, space exploration and so on. In this workshop the combination of wireless power transmission, wireless communications and energy harvesting will be presented with clear applications in several use cases. Academics around the world and industry will be presenting their latest developments.</td>
</tr>
<tr>
<td>Health Aspects of mm-Wave Radiation in 5G and Beyond</td>
<td>Utilizing mm-waves in mobile communications has been known to be associated with much lower radiation powers and much shorter communication ranges. This has given rise to what are called “Microcells” and “Picocells”, whose coverage areas do not exceed a 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 do not 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. Another related relevant aspect is the very strong mm-wave attenuation in water-rich substances characterizing biological tissues. mm-Waves cannot therefore penetrate into biological objects (eg human and animal bodies and plants) more than few millimeters. Health aspects must therefore be investigated within the skin area. Deeper inside the body, mm-waves assume negligible intensities, which are much safer than those of earlier standards (eg 3G and 4G). 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. The expected results should be very calming for the public, as it will be shown that the major standards (eg ICNIRP, IEEE, and ANSI) allow for harmless radiation levels, and this has been justified by the long-time experience with man-made radiation in the last decades (broadcasting and different wireless communication modalities). It will also be shown that social-media widely-spread views of pseudoscience and conspiracy theorists claiming serious health hazards, which are caused generally by mm-wave radiation and particularly as related to 5G and beyond, are clearly BASELESS. To a great extent, these claims are based on mixing up ionizing and nonionizing radiation. The mechanisms of wave-matter interactions in the latter are fully described by the constitutive parameters: permittivity, permeability, and conductivity for weak and moderate field intensities that do not involve nonlinearities. These are macroscopic quantities (spatial moving averages) that average out spatial microscopic details. The averaging window is at most a few hundredths of wavelength wide. Possible changes in critical and sensitive atomic or molecular structures (similar to that existing in eg DNA or nerve cells) cannot considerably exceed the macroscopic average. The latter is a reversible thermal one, as long as the radiated power levels do not exceed those dictated by the Regulatory Agencies (eg FCC in USA).</td>
</tr>
<tr>
<td>Micro and Nano Technology Challenges to Address 6G Key Performance Indicators</td>
<td>Telecom communities are beginning to prepare the next generation of mobile telecom, the 6G, and present KPIs going to the Tbps, 300GHz carrier frequency, space multiplexing, spectrum agility, dense Massive MIMO, wide bands, and so forth. Serving these challenges, microelectronics communities must re-think their medium term roadmap: what role can CMOS processes play? Is SiGe HBT a good answer to these KPIs? Do we need more exotic technologies such as III-V HBT or HEMT? How to do Heterogeneous Integrations, in a 3D approach? How to integrate antennas and passives?</td>
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SUNDAY WORKSHOPS

COLORADO CONVENTION CENTER

08:00 – 17:00 | Sunday, 19 June 2022

WORKSHOP ABSTRACT

The Power Amplifier (PA) continues to be a critical building block in mm-wave communication systems, often dictating the overall system efficiency and can thereby impose constraints on system deployment (e.g., max phased-array size due to thermal constraints). As such, many publications focus on efficiency enhancement techniques for mm-wave power amplifiers. However, when used in systems targeting “5G and Beyond” applications, transceiver bandwidths must be suitable to meet the high data-rate specifications, and hence, maximum PA efficiency cannot be blindly pursued. Instead, efficiency enhancement techniques must be explored in close consideration of their implications on bandwidth, which is what this workshop aims to explore more deeply. The goal of this workshop is three-fold: 1) familiarize the audience with PA specifications required for next-gen applications, 2) review well-known (and emerging) efficiency enhancement techniques for mm-wave PAs with perspectives on attainable bandwidth, and 3) discuss techniques to enhance bandwidth while maintaining adequate efficiency required for practical systems. The workshop features talks which will highlight PA specifications for two of the forefront “5G and Beyond” applications — radar and large-scale phased-arrays — covering the 20-100+ GHz, along with reference designs suitable for such applications. In addition, there will be discussion on design methodologies for maximizing bandwidth while optimizing efficiency in the context of mm-wave and sub-Thz linear amplifiers and mm-wave Doherty amplifiers. Lastly, an emerging efficiency enhancement technique, the sub-harmonic switching amplifier, will also be presented.

Quantum computers hold the promise to perform certain complex calculations that are not solvable even with today’s most powerful supercomputers. Despite the significant progress made in the last decade in the science and engineering of quantum computing systems, several challenges remain before quantum computation can become practically usable. A key challenge relates to system scalability — fault-tolerant quantum computation will likely require thousands or millions of quantum bits (qubits), far beyond the capacity of current prototypes. Today’s most prominent candidate for implementing large-scale systems, the superconducting qubit platform, operates in the microwave regime and is controlled and readout via conventional microwave electronics operating at room temperature. While the current room temperature control and readout approach works for small-scale experiments, it is not scalable to thousands or millions of qubits. The engineering challenges of realizing practical large-scale systems present quantum microwave engineers with new opportunities in microwave modeling, design, and characterization of cryogenic semiconductor and superconductor devices, circuits, and systems. This workshop will address emerging techniques and technologies for quantum information processing, including low-temperature measurements and calibrations, cryogenic packaging and interconnects, monolithic semiconductor-based quantum processors, and quantum-classical interfaces based on cryogenic CMOS and Josephson superconductive electronics.

With recent 5G deployment underway, the focus of wireless research is shifting toward 6G, which is expected to have a peak data rate of 1Tb/s and air latency less than 100 microseconds, 50 times the peak data rate and one-tenth the latency of 5G. To achieve Tb/s transmissions in 6G, it is inevitable to utilize the frequency band over 100GHz or sub-Thz due to enormous amount of available bandwidth. However, the use of such high frequency bands results in more design challenges of RF circuits including output power, noise, linearity, signal conversion, and high-quality signal source for 6G communications and sensing. In addition, the optimal phased array architecture needs to be carefully analyzed such that the compact and energy-efficient system package can be attained. Moreover, to compensate for the severe mm-wave or sub-Thz path loss, a large number of phased array is required to enhance ERP and SNR while appropriate designs are necessary to establish reliable wireless links and ensure the array performance. Failure in any of these will prevent us from moving forward regarding the development of 6G. In this workshop, the main theme to be discussed concentrates on mm-wave design challenges and solutions for 6G wireless communications, especially targeting RF circuits. The workshop starts with an overview of mm-wave 6G to illustrate the whole picture to the audience. Afterwards, the RF design challenges based on silicon technologies to realize 6G systems are paid more attention while the innovative design techniques are provided such that the advantages of low cost and high-level integration in silicon can be still obtained. For in-depth exploration, being a critical building block in RF front-ends, mm-wave and sub-Thz PA is specially under discussion to investigate the design bottlenecks as well as technology limitations, and the potential solutions and technology directions are presented. Besides RF designs, the analysis of phased-array architecture suitable for 6G applications is mentioned while the analog and digital beamforming structures are compared. In this workshop, to overcome the hurdles arising from silicon technologies, a new silicon-compatible III-V technology is introduced to facilitate 6G RF front-end designs. This workshop also covers the mm-wave and sub-Thz communication and sensing systems from the top-down perspective for the comprehensive demonstration of 6G realization.

The amount of sensing applications at mm-wave frequencies is continuously growing. Most of the applications can be addressed by classical radar techniques, but not all. Additional types of novel energy efficient sensing concepts for near-field imaging arrays and spectroscopy are being investigated. This full-day workshop covers near-field sensing and advanced state of the art radar techniques at mm-wave and THz frequencies. The intention is to showcase the unique applications and innovative concepts for sensing different materials and parameters including vital signs, small motions and distances, permittivity, humidity and gas density, and biomolecules using mm-wave to THz frequencies. The first half of the workshop will focus on various solutions for mm-wave and THz imaging and spectroscopy. For example, real-time THz super-resolution near-field imaging will be discussed, as well as transceivers at THz for gas spectroscopy. Advantages and disadvantages of various sensing approaches will be discussed. In the second half, we will discuss the latest trends and future directions in mm-wave radar. We will focus specifically on novel mm-wave radar modulation schemes, advanced system and circuit realizations. The emphasis is on digital radar modulation techniques, such as OFDM, PMCW, spread-spectrum, and their advantages or disadvantages versus classical FMCW radar realizations. The main idea of the workshop is to give an overview on mm-wave and THz sensing concepts and show the future directions for the advanced mm-wave radar transceivers.
<table>
<thead>
<tr>
<th>WORKSHOP TITLE</th>
<th>WORKSHOP ABSTRACT</th>
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| WSM | Advanced Interference Mitigation in Integrated Wireless Transceivers  
Sponsor: RFIC  
Organizers: Alyoasha Molnar, Cornell Univ.; Harish Krishnaswamy, Columbia Univ.; Jin Zhou, Univ. of Illinois at Urbana-Champaign  
ROOMS: 503/504  
08:00 – 17:00 | Modern transceivers often rely on many discrete components, such as SAW and BAW filters and duplexers, to protect them from interference. The number of these discrete front-end components is expected to grow further as more bands are made available at RF and mm-wave frequencies, limiting the system cost, form factor and flexibility. Also, while integrated self-interference cancellation has been demonstrated, many challenges remain at the antenna interface and scaling to phased-array and MIMO transceivers. In this workshop, experts from academia and industry will present the state-of-the-art interference mitigation approaches that can be applied to integrated wireless transceivers. Finally, the workshop will conclude with an interactive panel discussion about the potential and limitations of integrated interference mitigation. |
| WSM | System Design Considerations for Advanced Radios  
Sponsor: RFIC  
Organizers: Oren Eliezer, Ambiq; Raja Pullela, MaxLinear; Travis Forbes, Sandia National Laboratories  
ROOMS: 605/607  
08:00 – 17:00 | This workshop will walk you through the steps involved in designing today’s complex radios for applications such as infrastructure cellular, Wi-Fi or mm-wave beam forming arrays from a systems perspective. The workshop caters to students, as well as experienced engineers in the industry, with background in RF systems, circuit design or standards, who are interested in expanding the scope of their knowledge beyond the narrow design tasks they may be exposed to. Attendees will learn how system specifications are derived, how we partition design between RF/Analog/Mixed-signal and digital sections to achieve the most optimum solution in terms of size, power, external BOM. You will hear from speakers who are experts in their areas: a mix from industry and academia. Standards related specification and product level requirements that drive architecture or topology choices will be presented. Using Wi-Fi 802.11be emerging standard as an example, we will outline the salient features and how they compare with previous generations. We will address design considerations imposed by the new standard requirements, with particular focus on RF. Presentations focused on base station cellular transceivers will illustrate the differences between narrow-band (mixer-based) and Direct Sampling/Synthesis approaches. Using microwave and mm-wave point to point communication systems, we will go over design aspects such as line-up analysis to arrive at block level specifications. We will present transmit/receive circuit/system challenges in large-scale arrays, followed by approaches towards realizing scalable, digital-intensive large-scale arrays. Design advances in critical building blocks, such as blocker tolerant receivers and ADPLLs will also be discussed. We will present built-in self-calibration techniques and built-in mitigation of self-interference, leading to reduced production testing costs and high production yields. Calibration techniques to overcome impairments such as IQ error or LO offset calibration and Digital Pre-Distortion (DPD) for linearization of power amplifiers will be discussed. |
| WSK | Toward Tb/s Optical and Wireline Transceivers: a Tutorial for RFIC Designers  
Sponsors: IMS; RFIC  
Organizers: Bahar Jalali Farahani, Cisco; Mahdi Parvizi, Cisco  
ROOMS: 705/707/709/711  
08:00 – 12:00 | According to the latest report by Global Market Insights Inc, the market valuation of optical communication and networking will cross $30 billion by 2027. The significant revenue comes from the emerging technologies such as IoT (Internet of Things), machine-to-machine networks, AI, cloud-based services, and web-based applications. Several innovations are underway to enhance the wireline and optical transceiver designs so that they can serve the increase in demand and future generations of applications. |
| WSL | Wireless Proximity Communication  
Sponsors: IMS; RFIC  
Organizers: Rocco Tam, NXP Semiconductors; Yao-Hong Liu, IMEC  
ROOMS: 705/707/709/711  
13:30 – 17:00 | Wireless proximity communication provides many unique features over conventional wireless communication such as ultra-high data rate, superior data privacy, energy efficiency, mechanical reliability, precision ranging and bandwidth density. However, these unique features always come with many design trade-offs in system complexity, effective communication distance, energy efficiency and system robustness. In this workshop, we are going to go over several wireless proximity communication techniques such as Mid-Field powering and communication for bio-medical implants, impulse ultra-wide-band and mm-wave. The first and second workshops will introduce the applications in latest UWB standard (IEEE 802.15.4q), and the design trade off in commercial UWB SoC system and circuit design. The third workshop will focus on Mid-Field technology for powering and communication with biomedical neuromodulation implants. This technology offers advantages such as significantly smaller, implanted deeper, implant complexity, patient complication and post-surgical pain. The last workshop presents the overview of solid-state-based mm-wave wireless interconnects from fundamental research to commercialization. |
| WSN | Recent Developments in Sub-6GHz PAs and Front-End Modules  
Sponsors: RFIC; IMS  
Organizers: Alexandre Giry, CEA-LETI; Jennifer Kitchen, Arizona State Univ.  
ROOMS: 702/704/706  
08:00 – 12:00 | Increasing demand for high data rates, reduced latency, and increased device density are driving the development of 5G wireless systems. 5G spectrum is presently covering sub-7GHz (FR1) and mm-wave bands (FR2, FR3, ...). This workshop will bring together experts from academia and industry to highlight recent works and performance trends related to 5G-FR1 Power Amplifiers (PAs) and Front-End Modules (FEMs). Multiband and high linearity requirements, along with the need for higher power and reduced power consumption, make the design of 5G-FR1 PA and FEM highly challenging and critical to overall system performance. Recent trends in Doherty, class F/F', multi-stage PAs, and Envelope Tracking PA architectures will be highlighted and insights into different designs techniques and integration technologies (CMOS, SOI, GaN) will be presented as pathways to enable the integration of future PAs and FEMs. An introduction to emerging heterogeneous technologies combining high-power GaN with CMOS will also provide the attendees with new directions for next-generation PA design and integration. |
**WORKSHOP TITLE**  
**WORKSHOP ABSTRACT**

**WSN**  
Digitally Intensive PAs and Transmitters for RF Communication  
Sponsor: RFI  
Organizers: Xun Luo, UESTC; Debopriyo Chowdhury, Broadcom  
ROOMS: 702/704/706  
13:30 – 17:00

The power amplifiers (PA) and transmitters are the last door in the RF front-end for both the digital and analog kingdoms, one which greatly affects the quality of service (QoS) of the wireless link for modern RF communication, such as 5G, IoT, and beyond. Due to the multi-function trends nowadays, this workshop will showcase the digitally intensive PAs and transmitters, which attract much attention due to their highly reconfigurable nature and rapid development that is on pace with the decreasing scale of CMOS technology. In the first talk, with the aim to powering the next generation of wireless communication, from RF to mm-wave, a series of switched capacitor power amplifiers are discussed. Then, CMOS digital power amplifier and transmitter for efficient signal amplification and beam steering are introduced in the second talk. Next, in the third talk, the all digital transmitter with GaN switching mode power amplifiers with high power efficiency is discussed. Later, digital polar transmitter for impulse-radio ultrawide band communication is introduced in the fourth talk. Finally, the high-performance digital-to-analog converter design towards a digital transmitter is discussed in the fifth talk.

**WSO**  
Human Body Communications  
Sponsor: RFI  
Organizers: Antoine Frappé, IEMN (UMR 8520); François Rivet, IMS (UMR 5218); Fred Lee, Twenty/Twenty Therapeutics  
ROOMS: 708/710/712  
08:00 – 12:00

The human body is a new playground for wireless communications to connect health devices or open new services related to information exchange or security. It faces many constraints such as power consumption, quality of service, reliability, and of course being compatible with the human body. The last decade has seen several innovations that exploit the body as a medium to propagate the information efficiently. This workshop proposes a state-of-the-art of up-to-date research on the topic. It starts with an overview of body area networks and pioneering research on communications and power delivery through the body. It is followed by recent developments on broadband human-body communication transceivers for wearable health monitoring. Then, surface-wave capacitive body-coupled communications are introduced and challenges for upper layers and synchronization of nodes are addressed. Finally, intra-body communications using ultrasounds are explored to complete the scope of this workshop.

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**IMS2022 QUANTUM WEEK**

The IMS2022 Quantum Week is a special event organized by the MTT-S Quantum Technologies Working Group and is aimed to strengthen collaboration between the MTT-S and quantum communities. There is an array of technical and social activities including plenaries/keynotes, technical sessions, workshops, a bootcamp, and a reception. To encourage attendance from quantum industry, the Quantum Economic Development Consortium (QED-C) will be collocating a meeting with IMS.

**Sunday, 19 June**  
WSF: Emerging Low-Temperature/Cryogenic Microwave Techniques and Technologies for Quantum Information Processing  
Quantum Bootcamp

**Monday, 20 June**  
WMF: Superposition and Entanglement: When Microwaves meet Quantum  
WMP: Quantum RF Receivers: Using Rydberg Atoms for Highly Sensitive and Ultra Wideband Electric Field Sensing

**Tuesday, 21 June**  
Tu1E: Microwave Technologies for Quantum-System Integration  
Tu2E: Cryogenic Microwave Circuits for Control of Quantum Systems  
PL2: This is the Right Way to Architect the Microwave Control for Quantum Computers!  
Tu3E: Cryogenic Measurement and Characterization for Quantum Systems  
IWTU4: Accelerated Solid State Qubit Pre-Screening  
IWTU5: Mixed-mode/Differential S-parameter Characterization at Cryogenic Temperatures for Quantum Computing Applications  
Quantum Reception

**Wednesday, 22 June and Thursday, 23 June**  
QED-C (Hyatt Regency Denver)

**QUANTUM BOOT CAMP**  
08:00 – 12:00  
Sunday, 19 June 2022  
Room: 505-507

This course will provide an introduction to the basics of quantum engineering, targeting microwave engineers who want to understand how they can make an impact in this emerging field. The intended audience includes new engineers, engineers who may be changing their career path, marketing and sales professionals seeking a better understanding of quantum technology, as well as current university students looking to learn more about the practical aspects of Quantum technology. The format of the Quantum Boot Camp is like that of a short course, with speakers covering quantum engineering basics with a focus on the control and measurement of quantum systems and will conclude with a hands-on introduction to the design of superconducting qubits using modern microwave CAD tools. The boot camp is geared towards making the remainder of quantum-week more accessible to attendees.

**Speakers/Instructors:**

Thomas McConkey (IBM)  
Kevin O’Brien (MIT)
**RFIC TECHNICAL LECTURE**

**LECTURE TITLE**
- Fundamentals of Noise, and Understanding its Effects on RFICs
  
**LECTURE ABSTRACT**
Even circuit designers who are experienced with low noise design can find it difficult to explain how noise is quantified and analyzed.

I will explain the formal methods of quantifying noise and illustrate their use in the design of a variety of common RF circuits. For linear time-invariant circuits such as small-signal amplifiers, noise transfer functions play a key role. For time-varying circuits such as passive mixers and LC oscillators, noise is in many cases injected in discrete time. Methods for the design continue to evolve towards greater simplicity, and I will present some of them.

There is seldom a noise optimum in these circuits. It is usually a tradeoff, as I will show, between noise, large-signal linearity, and power dissipation.

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**RFIC PLENARY SESSION**

**The Future of RFIC is Digital**

**Dr. Curtis Ling, Chief Technology Officer, MaxLinear**

**ABSTRACT:** The successful integration of high-performance communication systems in monolithic silicon over the past twenty years is the result of digital circuits becoming an integral part of the analog front end. An important focus of “digital + analog” chip design has been on circuit impairment suppression, which is to say, making analog circuits behave more ideally. Two important examples are the proliferation of direct conversion receivers in high performance applications (to the point of becoming almost passé); and linearization techniques integrated within transceiver signal paths. What will happen as technology scaling continues to feed digital performance without proportional improvements in RF? This talk will briefly examine the evolution and current state of communication systems-on-chips, highlighting the role of digitally-enabled analog in current state of the art; then explore ways in which digital + analog front ends might become increasingly relevant to systems design and network architecture.

**BIOGRAPHY:** Curtis Ling, Ph.D. is a co-founder of MaxLinear and has served as Chief Technical Officer since April 2006. From March 2004 to July 2006, Dr. Ling served as Chief Financial Officer, and from September 2003 to March 2004, as a co-founder, he consulted for MaxLinear. From July 1999 to July 2003, Dr. Ling served as a principal engineer at Silicon Wave, Inc. From August 1993 to May 1999, Dr. Ling served as a professor at the Hong Kong University of Science and Technology. Dr. Ling received a B.S. in Electrical Engineering from the California Institute of Technology and an M.S. and Ph.D. in Electrical Engineering from the University of Michigan, Ann Arbor.

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**RFICs into the Roaring 20’s: Hot and Cold**

**Prof. Sorin P. Voinigescu, Stanley Ho Chair of Microelectronics, Director of the VLSI Research Group, Professor of Electrical and Computer Engineering, University of Toronto**

**ABSTRACT:** In this talk, I will look ahead to the challenges and research problems RFIC designers will have to address through the end of the decade. With the end of III-V and silicon-based transistor performance scaling in sight, the push for higher operation frequency, bandwidth, data rate, and dynamic range will continue unabated for the main economic drivers in our field: radio, radar sensors, and for the fiberoptic infrastructure that enables all of them. With little fanfare, the baseband of fiberoptic systems is now approaching 100 GHz, higher than 5G and automotive radar carrier frequencies, with over 200 GS/s sampling rate required for ADCs and DACs. Adding AI elements to all these applications may lead us to the “metaverse,” but the power consumption of each RFIC function will have to be drastically reduced if we do not wish to melt this “universe.” The good news is that the high frequency performance of all transistor technologies improves by ~30% in the cold down to 70 Kelvin and remains excellent at 2 Kelvin. This will open niche markets for RFICs in space and quantum computing which are likely to grow rapidly. Classical computing, data centers, and AI will also greatly benefit from 77 Kelvin operation, improving speed and reducing the power consumption of the classical computation function. I will wrap up with examples of representative RFICs for all these applications and of the research problems that still need solutions.

**BIOGRAPHY:** Sorin P. Voinigescu is a Professor in the Electrical and Computer Engineering Department at the University of Toronto where he holds the Stanley Ho Chair in Microelectronics and is the Director of the VLSI Research Group. He is an IEEE Fellow and an expert on millimetre-wave, 100+Gbaud integrated circuits and atomic-scale semiconductor device technologies and has an established research and development track record in industry (Nortel, Quake Technologies, Peraso Technologies). He obtained his PhD degree in Electrical and Computer Engineering from the University of Toronto in 1994 and his M.Sc. Degree in Electronics and Telecommunications from the Polytechnical Institute of Bucharest in 1984.
### RFIC Student Paper Awards Finalists:

1. **A Millimeter-Wave Mixer-First Receiver with Non-Uniform Time-Approximation Filter Achieving >45dB Blocker Rejection**
   - By Aydin Babakhani, University of Southern California, USA
   - Co-authors: Iman Habibagahi, Jaeeun Jang, Said Rami, Intel, USA, Qiang Yu, Jeffrey Garrett, Seahee Hwangbo, Georgios Dogiamis, Moody, Andrew Suchanek, Spencer Nelson, Travis Forbes, Benjamin Magstadt, Jesse Sandia National Laboratories, USA
   - *Showcase*

2. **A Wireless Network of 8.9um² Bio-Implants Featuring Adaptive Magnetoelastic Power and Multi-Access Bidirectional Telemetry**
   - By Zhenghao Yu, Wei Wang, Joshua C. Chen, Zhiyu Chen, Yan He, Amanda Singer, Jacob T. Robinson, Kaiyuan Yang, Rice University, USA
   - *Showcase* (RM01C-2)

3. **A DC-to-18GHz SPI10F RF Switch Using Symmetrically-Routed Series-TL-Shunt and Reconfigurable Single-Pole Network Topologies Presenting 1.1-to-3.2dB IL in 0.15um GaAs pHEMT**
   - By Zhaowu Wang, Zhenyu Wang, Tao Yang, Yong Wang, Nokias Bell Labs, USA, D. Parat, A. Serhan, P. Reynier, R. Mourot, A. Giry, 2Jet Propulsion Laboratory, USA
   - *Demonstration* (RM02B-1)

4. **A Sub-THz CMOS Molecular Clock with 20ppm Stability at 10,000s**
   - Based on Dual-Loop Spectroscopic Detection and Digital Frequency Error Integration
   - By Mina Kim, Cheng Wang, Lin Yi, Hae-Seung Lee, Ruonan Han, MIT, USA, 2Jet Propulsion Laboratory, USA
   - *Showcase* (RM03A-1)

5. **A 2MHz 4–48V VIN Flying-Capacitor Based Floating-Ground GaN DC-DC Converter with Real-Time Inductor Peak-Current Detection and 6µs Load Transient Response**
   - By Weizhong Chen, Chang Yang, Lei Chen, Ping Gui, Southern Methodist University, USA; Texas Instruments, USA
   - *Demonstration* (RM03B-5)

### RFIC Industry Paper Awards Finalists:

1. **A Linear High-Power Reconfigurable SOI-CMOS Front-End Module for Wi-Fi 6/6E Applications**
   - By CEAT-Leti, France, D. Parat, A. Serhan, P. Reynier, R. Mourot, A. Giry
   - *Showcase* (RMo1B-5)

2. **An All-Silicon E-Band Backhaun-on-Glass Frequency Division Duplex Module with >24dBm PSAT & 8dB NF**
   - By Nokia Bell Labs, USA, Shahriar Shahramian, Michael Holyoak, Mike Zierd, Joe Weiner, Amir Singh, Yves Baeyens
   - *Demonstration* (RM02A-1)

3. **A 0.2–2GHz Time-Interleaved Multi-Stage Switched-Capacitor Delay Element Achieving 448.6ns Delay and 330ns/mm² Area Efficiency**
   - By Sandia National Laboratories, USA, Travis Forbes, Benjamin Magstadt, Jesse Moody, Andrew Suchanek, Spencer Nelson
   - *Demonstration* (RM03B-1)

4. **An F-Band Power Amplifier with Skip-Layer Via Achieving 23.8% PAE in FinFET Technology**
   - By Intel, USA, Qiang Yu, Jeffrey Garrett, Seahee Hwangbo, Georgios Dogiamis, Said Rami
   - *Demonstration* (RM04A-2)

5. **A 2GHz 9.9pJ/b Sub-10GHz Wireless Transceiver for Reconfigurable FDD Wireless Networks and Short-Range Multicast Applications**
   - By Intel, USA, Intel, Mexico, Renzhi Liu, Asma Beevi K. T., Richard Dorrance, Timothy Cox, Rinkle Jain, Tolga Ackilkan, Zhen Zhou, Tae-Young Yang, Johanny Escobar-Pelaez, Shuhei Yamada, Kenneth Foust, Brent Carlson
   - *Finalist Only* (RTu4A-1)

   - By CEA-Leti, France, Abdelaziz Hamani, Francesco Foglia Manzillo, Alexandre Siligaris, Nicolas Cassiau, Frederic Hameau, Fabrice Chaux, Cedric Dehos, Antonio Clemente, Jose Luis Gonzalez-Jimenez
   - *Demonstration* (RM02A-5)

### Systems and Applications Forum Showcase/Demonstrations:

1. **Miniaturized Wirelessly Powered and Controlled Implants for Vagus Nerve Stimulation**
   - By University of California, Los Angeles, USA, Iman Habibagahi, Jaejun Jang, Aydin Babakhani
   - *Demonstration* (RM01C-3)

2. **A 21.8–41.6GHz Fast-Locking Sub-Sampling PLL with Dead Zone Automatic Controller Achieving 62.7fs Jitter and 250.3dB FoM**
   - By Wen Chen, Yiyan Shu, Huizhen Jenny Qian, Jun Yin, Pui-In Mak, Xiang Gao, Xun Luo, UESTC, China, University of Macau, China, Zhejiang University, China
   - *Demonstration* (RM03C-2)

   - By Xiaohan Zhang, I. Sansen, Daquan Huang, Taiyun Chi, Rice University, USA, Samsung, USA
   - *Demonstration* (RTu1B-1)

4. **An Integrated Reconfigurable SAW-Less Quadrature Balanced N-Path Transceiver for Frequency-Division and Half Duplex Wireless**
   - By Erez Zolkov, Nimrod Ginberg, Emanuel Cohen, Technion, Israel
   - *Finalist Only* (RTu3A-1)

5. **Fully Integrated Ultra-Wideband Differential Circulator Based on Sequentially Switched Delay Line in 28nm FDSOI CMOS**
   - By Jun Hwang, Byung-Wook Min, Yonsei University, Korea
   - *Demonstration* (RTu3B-2)

   - By Xiaohan Zhang, I. Sansen, Daquan Huang, Taiyun Chi, Rice University, USA, Samsung, USA
   - *Demonstration* (RTu1B-1)

7. **A 56.32Gb/s 16-QAM D-Band Wireless Link Using RX-TX Systems-in-Package with Integrated Multi-L0 Generators in 45nm RFSOI**
   - By CEA-Leti, France, Abdelaziz Hamani, Francesco Foglia Manzillo, Alexandre Siligaris, Nicolas Cassiau, Frederic Hameau, Fabrice Chaux, Cedric Dehos, Antonio Clemente, Jose Luis Gonzalez-Jimenez
   - *Demonstration* (RM02A-5)

8. **DC to 12GHz, +30dBm OIP3, 7.2dB Noise Figure Active Balun in 130nm BiCMOS for RF Sampling Multi-Gbps Data Converters**
   - By Texas Instruments, USA, Siraj Akhter, Gerd Schuppener, Tolga Din, Baher Haroun, Swaminathan Sankaran
   - *Demonstration* (RM03B-2)
## 1A-1C
### RMo1A: mm-Wave Transmitters and Receivers for Communication and 5G Applications

**Chair:** Hossein Hashemi, Univ. of Southern California  
**Co-Chair:** Jeyanandh Paramesh, Carnegie Mellon Univ.

#### RMo1A-1: A Millimeter-Wave Mixer-First Receiver with Non-Uniform Time-Approximation Filter Achieving >45dB Blocker Rejection

C. Yang, Univ. of Southern California; S. Su, Univ. of Southern California; M.S.-W. Chen, Univ. of Southern California

#### RMo1A-2: A 28GHz/39GHz Dual-Band Four-Element MIMO RX with Beamspace Multiplexing at IF in 65nm CMOS


#### RMo1A-3: A Millimeter-Wave Front-End for FD/FDD Transceivers featuring an Embedded PA and an N-Path Filter Based Circulator Receiver

M. Pashaefar, Technische Universiteit Delft; L.C.N. de Vreede, Technische Universiteit Delft; M.S. Alavi, Technische Universiteit Delft

#### RMo1A-4: A Ka-Band Dual Circularly Polarized CMOS Transmitter with Adaptive Scan Impedance Tuner and Active XPD Calibration Technique for Satellite Terminal


#### RMo1A-5: A 8–30GHz Passive Harmonic Rejection Mixer with 8GHz Instantaneous IF Bandwidth in 4SRFSOI

A. Ahmed, Univ. of California, San Diego; G.M. Rebeiz, Univ. of California, San Diego

## 1D-1F
### RMo1B: Cryogenic and Advanced Front-End Circuits

**Chair:** Emanuel Cohen, Technion, Israel  
**Co-Chair:** Ramesh Harjani, University of Minnesota, USA

#### RMo1B-1: A 4.2–9.2GHz Cryogenic Transformer Feedback Low Noise Amplifier with 4.5K Noise Temperature and Noise-Power Matching in 22nm CMOS FDSOI

B. Lin, Georgia Tech; H. Mani, CryoElec; P. Marsh, Carbonics; R. Al Hadi, Alcatel; H. Wang, Georgia Tech

#### RMo1B-2: A 2.57mW 5.8–8.4GHz Cryogenic FinFET LNA for Qubit Readout

J. O. Plouchart, IBM; D. Yilma, IBM; J. Timmerwilke, IBM; S. Chakraborty, IBM; K. Tian, IBM; A. Valdes-Garcia, IBM; D. Friedman, IBM

#### RMo1B-3: A MIXER-FIRST RECEIVER FRONTEND WITH RESISTIVE-FEEDBACK BASEBAND ACHIEVING 200MHz IF BANDWIDTH IN 65NM CMOS

B. Guo, CUH; H. Wang, CUH; Y. Wang, Zhengzhou Univ.; K. Li, CUH; L. Li, IESTC; W. Zhou, IESTC

#### RMo1B-4: A Feedback-Based N-Path Receiver with Reduced Input-Node Harmonic Response

V.S. Rayudu, Univ. of Texas at Austin; K.Y. Kim, Univ. of Texas at Austin; D.Z. Pan, Univ. of Texas at Austin; R. Gharpurey, Independent Researcher

### RMo1B-5: A Linear High-Power Reconfigurable SOI-CMOS Front-End Module for Wi-Fi 6/6E Applications

D. Parat, CEA-LETI; A. Serhan, CEA-LETI; P. Reynier, CEA-LETI; R. Mourot, CEA-LETI; A. Giry, CEA-LETI

## 4A-4C
### RMo1C: Emerging Applications of RFICs in Quantum, Biomedical and Communication Systems

**Chair:** Raja Pullela, MaxLinear, USA  
**Co-Chair:** Yao-Hong Liu, imec, The Netherlands

#### RMo1C-1: An Integrated Quantum Spin Control System in 180nm CMOS

K. Omirzakhov, Univ. of Pennsylvania; M.H. Ijadi, Univ. of Pennsylvania; T.Y. Huang, Univ. of Pennsylvania; S.A. Breitweiser, Univ. of Pennsylvania; D.A. Hopper, Univ. of Pennsylvania; L.C. Bassett, Univ. of Pennsylvania; F. Allatoumi, Univ. of Pennsylvania

#### RMo1C-2: A Wireless Network of 8.8mm³ Bio-Implants Featuring Adaptive Magnetoelectric Power and Multi-Access Bidirectional Telemetry


#### RMo1C-3: Miniaturized Wirelessly Powered and Controlled Implants for Vagus Nerve Stimulation

I. Habibagahi, Univ. of California, Los Angeles; J. Jang, Univ. of California, Los Angeles; A. Babakhani, Univ. of California, Los Angeles

#### RMo1C-4: Multi-Beam, Scalable 28GHz Relay Array with Frequency and Spatial Division Multiple Access Using Passive, High-Order N-Path Filters

P.P. Khial, Caltech; S. Nooshabadi, Caltech; A. Fikes, Caltech; A. Hajimiri, Caltech
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<td>Hongtao Xu, Fudan Univ., China; Qun Jane Gu, Univ. of California, Davis, USA</td>
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<td>1D-1F</td>
<td>RMo2B: Power Switches, Amplifiers and Power Dividers for mm-Wave and Sub-Thz Applications</td>
<td>Alyssa Apsel, Cornell Univ., USA; Alyssa Apsel, Cornell Univ., USA</td>
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<td>Wang, UESTC; Wang, UESTC; Yang, UESTC; Wang, UESTC</td>
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<td>Rack, Université catholique de Louvain; Nyssens, Université catholique de Louvain; Courte, Université catholique de Louvain; Ledener, Université catholique de Louvain; Raskin, Université catholique de Louvain</td>
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<td>RMo2A-3: A 40GHz Phase Shifter Arrayed FSO Transceiver Featuring Channel Aggregation Using HRM-Based Frequency Interleaving</td>
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<td>RMo2B-3: Analysis and Design of Dual-Peak Gmax-Core CMOS Amplifier in D-Band Embedding a T-Shaped Network</td>
<td>Kim, POSTECH; C.-G. Choi, POSTECH; Lee, POSTECH; Kim, POSTECH; U. Choi, POSTECH; H.-J. Song, POSTECH</td>
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<td>RMo2A-4: A 17Gbps 10.7pJ/b 4FSK Transceiver System for Point to Point Communication in 65nm CMOS</td>
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<td>RMo2B-4: 280.2/309.2GHz, 18.2/9.3dB Gain, 1.48/1.4dB Gain-per-mW, 3-Stage Amplifiers in 65nm CMOS Adopting Double-Embedded-Gmax-Core Technology</td>
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<td>RMo2B-5: 4-Way 0.031mm² Switchable Bidirectional Power Divider for 50 mm-Wave Beamformers</td>
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<td>RMo2B-2: A DC–120GHz SPD Switch Based on 22nm FD-SOI SLVT NFETs with Substrate Isolation Rings Towards Increased Shunt Impedance</td>
<td>Rack, Université catholique de Louvain; Nyssens, Université catholique de Louvain; Courte, Université catholique de Louvain; Ledener, Université catholique de Louvain; Raskin, Université catholique de Louvain</td>
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<td>RMo2B-4: 280.2/309.2GHz, 18.2/9.3dB Gain, 1.48/1.4dB Gain-per-mW, 3-Stage Amplifiers in 65nm CMOS Adopting Double-Embedded-Gmax-Core Technology</td>
<td>Yun, KAIST; D.-W. Park, Kumoh National Institute of Technology; G.-S. Choi, POSTECH; J.-H. Song, POSTECH; G.-S. Choi, KAIST</td>
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<td>RMo2B-5: 4-Way 0.031mm² Switchable Bidirectional Power Divider for 50 mm-Wave Beamformers</td>
<td>Francesco, IHP; Negra, RWTH Aachen Univ.; Malignaggi, IHP</td>
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**Technical Sessions Schedule**

**10:10 - 11:50**

- **SUNDAY**
  - RFIC TECHNICAL SESSIONS
- **MONDAY**
  - 1A-1C
  - 1D-1F
  - 4A-4C
### 1A-1C
**RM03A: mm-Wave and Sub-THz Circuits and Systems for Radar Sensing and Metrology**

**Chair:** Vito Giannini, Uhnder, USA  
**Co-Chair:** Vadim Issakov, Technische Universität Braunschweig, Germany

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<td>1A-1C 1</td>
<td>RM03A-1: A Sub-THz CMOS Molecular Clock with 20ppt Stability at 10,000s Based on Dual-Loop Spectroscopic Detection and Digital Frequency Error Integration</td>
<td>M. Kim, MIT; C. Wang, MIT; L. Yi, Jet Propulsion Lab; H.-S. Lee, MIT; R. Han, MIT</td>
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<td>1A-1C 2</td>
<td>RM03A-2: A Small-Area, Low-Power 76–81GHz HBT-Based Differential Power Detector for Built-In Self-test in Automotive Radar Applications</td>
<td>Y. Wenger, Technische Univ. Braunschweig; H.J. Ng, Hochschule Karlsruhe; F. Kornröhrer, IHP; B. Meinerzhagen, Technische Univ. Braunschweig; V. Issakov, Technische Univ. Braunschweig</td>
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<td>1A-1C 3</td>
<td>RM03A-3: A Compact 28nm FD-SOI CMOS 76–81GHz Automotive Band Receiver Path with Accurate 0.2° Phase Control Resolution</td>
<td>A. Le Ravalec, STMicroelectronics; P. Garcia, STMicroelectronics; J.C. Azevedo Gonçalves, STMicroelectronics; L. Vincent, CIME Nanotech; J.-M. Duchamp, G2Elab (UMR 5269); P. Benech, G2Elab (UMR 5269)</td>
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<td>1A-1C 4</td>
<td>RM03A-4: An E-Band Phase Modulated Pulse Radar SoC with an Analog Correlator</td>
<td>W. Zhou, Univ. of Minnesota; Y. Tousi, Univ. of Minnesota</td>
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<td>1A-1C 5</td>
<td>RM03A-5: A 29 to 36GHz 4TX/4RX Dual-Stream Phased-Array Joint Radar-Communication CMOS Transceiver Supporting Centimeter-Level 2D Imaging and 64-QAM OTA Wireless Link</td>
<td>F. Zhao, Tsinghua Univ.; W. Deng, Tsinghua Univ.; R. Wu, CAS; H. Jia, Tsinghua Univ.; Q. Wu, Tsinghua Univ.; J. Xin, CAS; Z. Zeng, CAS; Y. Li, CAS; Z. Wang, RITS; B. Chi, Tsinghua Univ.</td>
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### 1D-1F
**RM03B: Mixed-Signal Building Blocks for Next-Generation Systems**

**Chair:** Subhanshu Gupta, Washington State Univ., USA  
**Co-Chair:** Bahar Jalali Farahani, Cisco, USA

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<td>RM03B-1: A 0.2–2GHz Time-Interleaved Multi-Stage Switched-Capacitor Delay Element Achieving 448.8ns Delay and 330ns/mm² Area Efficiency</td>
<td>T. Forbes, Sandia National Laboratories; B. Magstadt, Sandia National Laboratories; J. Moody, Sandia National Laboratories; A. Suchanek, Sandia National Laboratories; S. Nelson, Sandia National Laboratories</td>
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<td>1D-1F 2</td>
<td>RM03B-2: DC to 12+GHz, +30dBm OIP3, 7.2dB Noise Figure Active Balun in 130nm BICMOS for RF Sampling Multi-Gbps Data Converters</td>
<td>S. Akhtar, Texas Instruments; G. Schuppener, Texas Instruments; T. Dinc, Texas Instruments; B. Haroun, Texas Instruments; S. Sankaran, Texas Instruments</td>
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<td>1D-1F 3</td>
<td>RM03B-3: An 11GS/s 2×10b 20–26GHz Modulator Using Segmented Non-Linear RF-DACs and Non-Overlapping LO Signals</td>
<td>V. Åberg, Chalmers Univ. of Technology; C. Fager, Chalmers Univ. of Technology; R. Hou, Ericsson Research; L. Svensson, Chalmers Univ. of Technology</td>
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<td>1D-1F 4</td>
<td>RM03B-4: A 345μW 1GHz Process and Temperature Non-Overlapping LO Signals</td>
<td>S. Akhtar, Texas Instruments; G. Schuppener, Texas Instruments; T. Dinc, Texas Instruments; B. Haroun, Texas Instruments; S. Sankaran, Texas Instruments</td>
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### 4A-4C
**RM03C: Frequency Generation Techniques for 5G and IoT**

**Chair:** Wanghua Wu, Samsung, USA  
**Co-Chair:** Andrea Cathelin, STMicroelectronics, France

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<td>RM03C-1: Open-Source Fully-Synthesizable ADPLL for a Bluetooth Low-Energy Transmitter in 12nm FinFET Technology</td>
<td>K. Kwon, Univ. of Michigan; D. Abdelaty, Univ. of Michigan; D.D. Wentzloff, Univ. of Michigan</td>
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<td>4A-4C 2</td>
<td>RM03C-2: A 21.8–41.6GHz Fast-Locking Sub-Sampling PLL with Dead Zone Automatic Controller Achieving 62.7fs Jitter and -250.3dB FoM</td>
<td>W. Chen,UESTC; Y. Shu,UESTC; H.J. Qian,UESTC; J. Yin, Univ. of Macau; P.-I. Mak, Univ. of Macau; X. Gao, Zhejiang Univ.; X. Luo, UESTC</td>
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<td>4A-4C 3</td>
<td>RM03C-3: A 59fs-rms 35GHz PLL with FoM of -241dB in 0.18μm BICMOS/SiGe Technology</td>
<td>R. Bindiganaville, Univ. of Utah; A. Wahid, Univ. of Utah; J. Atkinson, Univ. of Utah; A. Tajalli, Univ. of Utah</td>
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<td>4A-4C 4</td>
<td>RM03C-4: A 14GHz Band Harmonic Tuned Low-Power Low-Phase-Noise VCO IC with a Novel Bias Feedback Circuit in 40nm CMOS SOI</td>
<td>M. Fang, Waseda Univ.; T. Yoshimasa, Waseda Univ.</td>
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<td>4A-4C 5</td>
<td>RM03C-5: A 5G 65nm PD-SOI CMOS 23.2–28.8GHz Low-Jitter Quadrature-Coupled Injection-Locked Digitally-Controlled Oscillator</td>
<td>R. Dumont, STMicroelectronics; M. De Matos, IMS (UMR 5218); A. Cathelin, STMicroelectronics; Y. Deval, IMS (UMR 5218)</td>
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<td>15:40</td>
<td>RFIC Technical Sessions 15:40 – 17:00</td>
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<td>RMo4A: Power Amplifiers for 100+ GHz Applications</td>
<td>Jennifer Kitchen, Arizona State Univ., USA</td>
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<td>RMo4A-1: A 22nm FD-SOI CMOS 2-Way D-Band Power Amplifier Achieving PAE of 7.7% at 9.6dBm OP1dB and 3.1% at 6dB Back-Off by Leveraging Adaptive Back-Gate Bias Technique</td>
<td>E. Rahimi, Keysight Technologies; F. Bozorgi, Barkhausen Institut; G. Hueber, Silicon Austria Labs</td>
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<td>RMo4A-2: An F-Band Power Amplifier with Skip-Layer Via Achieving 23.8% PAE in FinFET Technology</td>
<td>Q. Yu, Intel; J. Garrett, Intel; S. Hwangbo, Intel; G. Dogiamis, Intel; S. Rami, Intel</td>
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<td>RMo4A-3: A 97–107GHz Triple-Stacked-FET Power Amplifier with 23.7dB Peak Gain, 15.1dBm PSAT, and 18.6% PAEMAX in 28nm FD-SOI CMOS</td>
<td>K. Kim, POSTECH; K. Lee, POSTECH; S.-U. Choi, POSTECH; J. Kim, POSTECH; C.-G. Choi, POSTECH; H.-J. Song, POSTECH</td>
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<td>Alvin Joseph, GLOBALFOUNDRIES, USA</td>
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<td>RMo4B-2: Superior Reliability and Low Self-Heating of a 45nm CMOS 39GHz Power Amplifier for 5G mmWave Applications</td>
<td>P. Srinivasan, S. Syed, J.A. Sundaram, S. Moss, S. Jain, P. Colestock, N. Cahoon, A. Bandypadhyay, F. Guarin, B. Min, M. Gall, GLOBALFOUNDRIES</td>
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<td>RMo4B-3: Impact of Non-Conducting RF and DC Hot Carrier Stresses on FinFET Reliability for RF Power Amplifiers</td>
<td>X. Ding, Auburn Univ.; G. Niu, Auburn Univ.; H. Zhang, MaxLinear; W. Wang, MaxLinear; K. Imura, MaxLinear; F. Dai, Auburn Univ.</td>
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<td>RMo4B-4: Device for Protecting High Frequency and High Data Rate Interface Applications in FinFET Process Technologies</td>
<td>S. Parthasarathy, Analog Devices; R. Shumovich, Analog Devices; J. Salcedo, Analog Devices; R. Broughton-Blanchard, Analog Devices; J.-J. Hajar, Analog Devices</td>
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<td>Howard C. Luong, HKUST, China</td>
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<td>RMo4C-2: A 14.5–17.9GHz Harmonically-Coupled Quad-Core P-N Class-B DCO with -117.3dBc/Hz Phase Noise at 1MHz Offset in 28nm CMOS</td>
<td>I. Apostolina, Università di Pavia; D. Manstretta, Università di Pavia</td>
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<td>RMo4C-3: A Compact CMOS 76–82GHz Super-Harmonic VCO with 189dBc/Hz FoM Operating Based on Harmonic-Assisted ISF Manipulation</td>
<td>B. Moradi, Univ. of California, Irvine; X. Liu, Univ. of California, Irvine; M.M. Green, Univ. of California, Irvine; H. Aghasi, Univ. of California, Irvine</td>
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<td>RMo4C-4: Sub-THz Switch-Less Reconfigurable Triple-/Push-Push Dual-Band VCO for 5G Communication</td>
<td>S. Oh, Seoul National Univ.; J. Kim, Seoul National Univ.; J. Oh, Seoul National Univ.</td>
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| **WMA** Advanced Manufacturing and Design Techniques for Emerging 3D Microwave and mm-Wave RF Filters  
**Sponsors:** IMS  
**Organizers:** Dimitra Psychogiou, Univ. College Cork; Michael Höft, CAU; Roberto Gómez-García, Universidad de Alcalá  
**ROOMS:** 107/109/111/113  
**08:00 – 17:00**                                                                                                               | This workshop will focus on recent advances in emerging manufacturing and integration processes for 3D microwave and mm-wave RF filters for the next generation of wireless and satellite communication systems. In particular, the workshop will present new RF design and electromagnetic modeling techniques for new classes of RF filtering components (bandpass/bandstop filters, multi-band filters and multiplexers) based on well-established manufacturing processes such as CNC machining and Si-based microfabrication that enables the realization of RF filters from mm-waves to frequencies in the sub-THz region (eq 700GHz). Furthermore, the workshop will provide an overview of emerging digital additive manufacturing processes such as stereolithography, selective laser sintering for new types of materials such as ceramics, plastics and metals and their application to advanced RF filtering architectures. The potential of these processes for complex geometries as well as for RF filters with advanced RF performance, high-frequency of operation, small form factor and low weight will be discussed in detail. Lastly, the workshop will present new RF design methodologies and novel RF filtering architectures that are uniquely enabled by the manufacturing flexibility of 3D printing that facilitates the realization of unconventional shapes. |
| **WMB** Advances in SATCOM Phased-Arrays and Constellations for LEO, MEO and GEO Systems  
**Sponsors:** IMS  
**Organizers:** Gabriel M. Rebeiz, Univ. of California, San Diego  
**ROOMS:** 102/104/106  
**08:00 – 17:00**                                                                                                               | There has been a tremendous advance in satellite communications in the past 3 years. First, Starlink (LEO) has sent upwards of 1600 satellites and is now building 5000 user terminals A WEEK (all based on phased-arrays), OneWeb (LEO) has secured $5B of funding and has sent 400 satellites and will be ready for operation in December 2021, Amazon Kuiper is building their LEO constellation as we speak, SES with mPower and their 2000-beam phased-arrays in a MEO constellation can now provide 500 Mbps to thousands of ISP (internet service providers) at the same time, and Viasat and HNS have both launched their GEO Tbps satellites each with 300+ beams. All of these units require advanced phased-arrays on the ground for user terminals and SATCOM-On-the-Move. This workshop will address advances in these low-cost ground terminals and in the LEO/MEO/GEO constellations, and will present the silicon technologies needed for this work. |
| **WMC** Emerging MIT/PCM Based Reconfigurable Microwave Devices  
**Sponsors:** IMS  
**Organizers:** Atif Shamim, KAUST; Gwendolyn Hummel, Sandia National Laboratories; Tejinder Singh, Dell Technologies  
**ROOMS:** 108/110/112  
**08:00 – 17:00**                                                                                                               | The extremely crowded and rapidly changing modern spectral environment has significantly increased the demand for highly reconfigurable RF technologies of high performance and small size. While RF switches are key elements in modern wireless communications and defense applications, switch performance has been stagnant for the last decade. With 5G being rapidly implemented and 6G on the horizon, RF systems are moving to the mm-wave bands and the RF loss in fundamental elements such as switches is becoming even more critical. Many commercially available switch technologies have certain issues with at least one of the following: resistive load, capacitive interference, limited bandwidth, low power operation, and/or nonlinearity. Recent work on emerging chalcogenide phase change material (PCM)-based switches has demonstrated a breakthrough innovation and a new class of reconfigurable devices exhibiting high performance, better monolithic and heterogeneous integration capabilities with other switch technologies, exceptional figure of merit, and broadband RF response compared to various commercially available switch technologies. Along with PCMs, metal-insulator transition (MIT) material such as vanadium dioxide based devices have also gained significant interest and researchers around the globe have demonstrated various interesting applications using PCM/MIT including but not limited to tunable mm-wave components, reconfigurable electro-optical components, and resonant sensors. Several research groups and industries are working to mature these technologies for high performance and efficient future wireless systems. This workshop aims to trigger the discussion on emerging PCM/MIT technologies regarding recent innovations, challenges, integration possibilities, limitations, and future trends. |
| **WMD** Front-End Module Integration and Packaging for 6G and Beyond 100GHz Communication and Radar Systems  
**Sponsors:** IMS  
**Organizers:** Kamal Samanta, Sony; Kevin Xiaoxiong Gu, MetaWave  
**ROOMS:** 201/203  
**08:00 – 17:00**                                                                                                               | Research and development on mm-wave front-end implementations are expanding to a new frontier beyond 100GHz for emerging 6G communication and radar imaging applications. This proposed workshop covers the latest advancement of packaging and integration technologies for designing and implementing >100GHz front-end modules including in-depth discussions of different substrates, interconnects, antennas, co-design with RFICs, thermal management, system demos/prototypes, and so on. We plan to have 11 experts (5 from university/research institutes; 6 from industry) to present their pioneering works in this area: (1) Prof. Mark Rodwell from UCSB and Director of the SRC/DARPA ComSenTer Wireless Research Center, (2) Dr. Muhammad Furqan from Infineon, (3) Siddhartha Sinha from imec, (4) Dr. Telesphor Kangaija from Intel, (5) Dr. Alberto Valdes-Garcia from IBM Research, (6) Prof. Wolfgang Heinrich from the Ferdinand-Braun-Institut (FBI), (7) Dr. Augusto Gutierrez-Aitken from Northrop Grumman, (8) Dr. Jon Hacker from Teledyne, (9) Dr. Goutam Chattopadhyay from NASA JPL, (10) Prof. Emmanouil (Manos) M. Tentzeris from Georgia Tech, and (11) Dr. Venkatesh Srivinasa from Texas Instruments. |

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## MONDAY WORKSHOPS

### WORKSHOP TITLE | WORKSHOP ABSTRACT
--- | ---
**WME**

**In-Band Full-Duplex Integrated Devices and Systems**

**Sponsors:** IMS; RFIC  
**Organizers:** Kenneth E. Kolodziej, MIT Lincoln Laboratory; Timothy M. Hancock, DARPA  
**ROOMS:** 205/207  
**08:00 – 17:00**

Many wireless systems could benefit from the ability to transmit and receive on the same frequency at the same time, which is known as in-band full-duplex (IBFD) and/or simultaneous transmit and receive (STAR). As this area matures, research is shifting towards reducing device form factors and creating novel self-interference cancellation techniques along with completely-integrated IBFD transceivers. In this workshop, experts from industry, academic and federal research institutions will discuss the various approaches that can be taken to construct IBFD systems and devices in an integrated fashion. Additionally, a mini-panel session is planned where the workshop speakers will debate the answers to questions posed by attendees for an interactive discussion with the audience.

**WMF**

**Superposition and Entanglement: When Microwave Resonators Interact**

**Sponsors:** IMS  
**Organizers:** Fabio Sebastiano, Technische Universität Delft; Joseph Bardin, Google, UMass Amherst  
**ROOMS:** 401-402  
**08:00 – 17:00**

Microwave techniques are central to many modern quantum computing and quantum sensing platforms, ranging from those implemented using nonlinear microwave resonators — which sometimes are frequency tunable — and coupling between qubits is often mediated using tunable LC filter networks. The state of a superconducting quantum processor is controlled using microwave signaling and measured using microwave reflectometry. Similarly, spin-qubit and trapped-ion systems often rely heavily on microwave signaling for their operation. As the culmination of decades of research, quantum computers can now perform certain classes of computations that are impractical using classical supercomputers. While today’s quantum computers have largely been enabled by advances in commercial microwave technology, the quest to build these machines has also led to pioneering research that has pushed the limits of microwave amplification, packaging, filtering, and system design. In this workshop, leading researchers will describe progress in microwave technologies as applied to quantum computing and quantum sensing. The workshop is both broad and deep, covering microwave technologies that are used across the quantum computing landscape. At the high level, researchers will describe how microwave techniques are used to control superconducting spin, and trapped-ion based quantum processors, covering a wide array of topics ranging from how microwave fields can be used in the trapping and manipulation of single ions to modular and SoC-based control systems for next-generation superconducting and spin qubit based quantum computers. The workshop will also contain deep dives into areas such as the systematic design of near-quantum-limited microwave parametric amplifiers, superconducting interconnect and filtering networks, system level quantum-coherent microwave packaging techniques, the cryogenic noise limits of semiconductor amplifiers, and quantum sensor systems leveraging microwave techniques. Central to all talks is the connection between microwave technology and the quantum information sciences.

**WMG**

**Supply Modulation Techniques: From Device to System**

**Sponsors:** IMS  
**Organizers:** Olof Bengtsson, FBH; Roberto Quaglia, Cardiff Univ.  
**ROOMS:** 403-404  
**08:00 – 17:00**

Power amplifiers for high frequency applications can benefit greatly from the ability to dynamically vary the supply voltage. For example, when spectral efficient signals are used, their large amplitude dynamic generally requires a compromise between linearity and efficiency of the amplifier, leading to poor average efficiency. By applying supply modulation in the form of envelope tracking, the average efficiency can be enhanced significantly. The introduction of GaN technology has enabled highly efficient very fast switch-based supply modulators that are required for the very large instantaneous bandwidth in telecommunication for space and the future 5G systems. With the introductions of 5G the system frequency increase and power per PA is reduced by distributed PA solutions like MIMO. The same is true for space applications but here, the main motivation for the development of efficient solid-state solutions is the transfer from bulky tube based solutions. The large instantaneous bandwidth of the future telecom systems poses a challenge for dynamic supply modulation but the high frequency and reduced power allows for novel integrated solutions with reduced parasitic effects where the modulator and RFPA are integrated on the same chip. This workshop will: introduce the motivations and applications of supply modulation technologies for space and terrestrial telecommunication; discuss how RF transistor technologies affect the requirements of the supply modulator and the effectiveness of supply modulation; show advanced design techniques for the supply modulator and the integration with RF amplifier; present system level solutions including linearization of supply modulation-based amplifier systems. Moreover, two expert talks on supply modulation for dynamic power control in high power ISM systems is also considered and optimized, compact envelope tracking for 3D printers will enable cross-fertilization with fields adjacent to the microwave industry and permit a fruitful exchange of ideas. The organizer’s aim is to actively involve the audience in the discussion, in order to provide them with a useful experience. For this reason, an online quiz will involve the audience with questions that can be answered only by interacting with the speakers.

**WMH**

**RF Large-Signal Transistor Performance Limits Related to Reliability and Ruggedness in Mobile Circuit Applications**

**Sponsors:** IMS  
**Organizers:** Michael Schröter, Technische Universität Dresden; Peter Zampardi, Qorvo  
**ROOMS:** 505-507  
**08:00 – 12:00**

The focus of the workshop is to provide an overview on transistor performance limits in terms of reliably achievable RF output power of various semiconductor technologies that are presently competing for mobile radio-frequency (RF) applications such as 5G, 6G, automotive radar and imaging, operating in the mm-wave frequency range (ie 30GHz to 300GHz). Of particular interest here are power amplifiers, oscillators, Mach-Zehnder-interferometers, and all sorts of RF buffer circuits that drive transistors to their dynamic large-signal limits and are implemented in semiconductor technologies such as III-V HBTs, SiGe HBTs and FD-SOI-CMOS. The presentations will explore the presently quite heterogeneous approaches for determining the transistor related safe-operating-area in terms of reliability and ruggedness for designing circuits that are supposed to deliver high output power at high frequencies in mobile applications. The workshop starts with a tutorial on the design specifications of the above mentioned circuits and the corresponding requirements for large-signal dynamic transistor operation up to the mm-wave region. Based on this motivation, several presentations will outline, for each of the technologies, the state-of-the-art of transistor characterization for RF ruggedness as well as the device physics that cause degradation and the modeling approaches for including reliability aspects in process design kits. The workshop concludes with a tutorial on existing measurements methods for large-signal device testing in the mm-wave range.
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<td><strong>WMJ</strong> GaN/GaAs Technology Development and Heterogeneous Integration for Emerging mm-Wave Applications</td>
<td>Recent advances of the GaN/GaAs technology development have enabled RF module switching at extremely high frequency that Si devices cannot withstand. It has shaped the landscape of RF industry and enabled applications in mm-wave frequency bands. In this full-day workshop, 9 talks will be presented by highly-recognized industry leaders and technical experts across the globe. It covers the major breakthrough from the latest development of GaN/GaAs technology and integration, including 1) heterogeneous integration of GaN/GaAs MMIC, 2) exploratory RF devices for mm-wave, and 3) systems and use-cases of GaN/GaAs technologies. At the closing of the day, an interactive panel session will be conducted between speakers and audiences. It is expected that the workshop can provide a platform for the latest mm-wave technology breakthroughs and a forum to share views.</td>
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<td><strong>WMJ</strong> Microwave Techniques for Coexistence between 5G and Passive Scientific Systems</td>
<td>Passive, scientific microwave systems perform crucial functions: providing early warning to massive populations to protect from hurricanes, winter storms, and other natural disasters, and enabling scientific understanding of astronomical phenomena. The recent addition of fifth-generation (5G) wireless into mm-wave spectral bands near those designated for these sensitive scientific observations, and expected future expansion of wireless communications to additional, higher-frequency bands, has jeopardized the fidelity of these sensing operations due to interference. However, wireless communications connects societies across the globe, and is a key driver of global economic stimulation, and as such must continue to expand while ensuring scientific measurements can continue. This workshop will overview both this challenge and new solutions at the microwave circuit and system levels to provide coexistence between active and passive spectrum-use systems. The workshop begins with specific discussions of a roadmap for developing coexistence between passive scientific and 5G wireless systems from the National Science Foundation and European Space Agency, challenges faced by passive systems, and perspectives from the commercial wireless industry. With this background, the next talks highlight microwave circuit and systems innovations that form promising solutions to this problem, including reconfigurable circuit design for 5G wireless systems, artificially intelligent power amplifier arrays, and a spectral broker for coordination between active and passive systems. The workshop will conclude with a panel session for extensive audience interaction with all speakers.</td>
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<td><strong>WMK</strong> On-Wafer mm-Wave Measurements</td>
<td>Accurate on-wafer S-parameter measurement plays an important role in the development of mm-wave integrated circuits for communications and electronics applications. To this end, a group of international experts in this field will share their experience on making reliable on-wafer measurements at high frequencies (eg above 100GHz). The presenters come from different backgrounds — instrumentation manufacturers, metrology institutes, end-users in industry and academia — and so provide different perspectives on this topic. The emphasis of the workshop is on sharing practical tips (ie good practice) so that attendees can subsequently implement such methods in their own workplaces. The workshop will cover topics including calibration techniques, verification methods, guides on design of custom calibration standards, instrumentation, and applications, etc. The workshop includes two panel discussions: (i) an open discussion about the challenges/opportunities/outlooks for research into on-wafer measurements in coming years; and (ii) an opportunity for attendees to describe their own on-wafer measurement problems so that these can be discussed, and hopefully solved, during the workshop.</td>
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<tr>
<td><strong>WMJ</strong> Measurement and Modeling of Trapping and Thermal Effects of GaN HEMT Microwave PA Technology</td>
<td>Gallium nitride (GaN) high electron mobility transistors (HEMTs) are an excellent technology for various microwave power amplifier applications due to the underlying semiconductor’s wide bandgap, high breakdown voltage and large peak electron velocity. A key bottleneck to the technology’s widespread and long-term adoption into commercial and military applications is its inherent electrical reliability. The physical mechanisms of GaN HEMT electrical degradation are largely unresolved and actively under investigation. In this full-day workshop, international experts in the fields of microwave measurements, trap characterization, thermal characterization, reliability characterization, GaN HEMT nonlinear modeling, trap modeling, and TCAD modeling will present state-of-the-art research. This interactive workshop aims to inform and excite the attendees on the advances in multiple aspects of this technology. Starting with a GaN technology overview, the planned talks will inform the audience about measurement and characterization of this technology including the complex thermal, charge trapping, and long-term degradation phenomenon in these devices. The next part of the workshop covers the modeling and simulation research in GaN. Starting with an overview of modeling challenges in GaN devices, the workshop will cover the latest industry standard compact models and advances in TCAD-based modeling of GaN devices.</td>
</tr>
<tr>
<td>WORKSHOP TITLE</td>
<td>WORKSHOP ABSTRACT</td>
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<tr>
<td>Hands-On Phased Array Beamforming Using Open Source Hardware and Software</td>
<td>Phased array communications and radar systems are finding increased use in a variety of applications. This places a greater importance on training engineers and rapidly prototyping new phased array concepts. However, both these imperatives have historically been difficult and expensive. But a recent open source offering, the ADALM-PHASER, allows real beamforming hardware to be used for education, project proposals, and product development. This workshop will introduce that offering with lectures and hands on labs covering: software defined radio (SDR), phased array beamforming (steering angle and beam formation), antenna impairments (side lobes/tapering, grating lobes, beam squint, quantization sidelobes), Monopulse tracking implementation, and simple radar algorithm design. Each of these topics will be addressed with a short lecture, followed by the participants using the ADALM-PHASER hardware to directly explore the lecture topic.</td>
</tr>
<tr>
<td>AI/ML-Based Signal Processing for Wireless Channels</td>
<td>Digital signal processing (DSP) is the critical element to adapt dynamic wireless propagation media and mitigate nature and man-made impairments. Today’s model-based DSP techniques function well in the stationary wireless channel, which can be easily disrupted by the random events such as in-band interference, noise and non-stationary fading channels. Emerging AI/ML techniques have demonstrated unique capability to capture and mitigate these corner cases. These AI/machine learning techniques can significantly enhance the processing capability better than the legacy model-based DSP techniques. This workshop will illustrate several recent advances in AI/ML-based signal processing techniques to mitigate impairments, such as non-stationary channel fading, interference, and noise, in wireless channels to enable robust wireless communication and radar applications.</td>
</tr>
<tr>
<td>Commercial Applications of Medical RF, Microwave and mm-Wave Technology</td>
<td>Systems that utilize RF, microwave and mm-wave energy are becoming increasingly important in the commercial medical device world. In the design of new medical devices, the use of high-frequency electromagnetics must be considered. For example, an implant such as a pacemaker should not require surgically-based battery replacement, but should be wirelessly rechargeable. A neurostimulator should be configurable and controllable by a phone or tablet. A vital sign sensor should allow for non-contact measurements to maximize comfort and usability. Wearable medical sensors should stream data wirelessly to a central location for display and analysis by medical professionals. These examples are just a few of the reasons why RF, microwave and mm-wave devices are of increasing importance and can be routinely found in government approved medical devices around the world. As RF, microwave and mm-wave technology rapidly advances in the academic and commercial environment, it will continue to be adapted toward medical applications in new and interesting ways. Please join our panel of industry experts for an interactive discussion about the in-roads that high-frequency approaches have made in the medical device space. Example applications include high-power RF/microwave ablation for cancer and cardiac applications, radar-based vital-sign sensing, in-body or on-body communication systems, wireless-power techniques, and cell detection and characterization. Panelists will share their perspective on both the current state-of-the-art, as well as future applications of this invaluable technology. In addition to technical content, unique considerations for the industry such as clinical study development, the regulatory approval process and the marketing of medical devices will be discussed.</td>
</tr>
<tr>
<td>Quantum RF Receivers: Using Rydberg Atoms for Highly Sensitive and Ultra Wideband Electric Field Sensing</td>
<td>In the past 10 years, there has been a great push in the development of a fundamentally new International System of Units (SI) traceable approach to electric field sensing. Atom-based measurements allow for this direct SI-traceability, and as a result, usage of Rydberg atoms (traceable through Planck’s constant) have greatly matured via measurement techniques and sensor head developments. Current Rydberg atom sensors have the capability of measuring amplitude, polarization, and phase of RF fields. Promising benefits of this quantum technology for RF receivers are the extremely large tuning range from DC fields to the submillimeter range, high selectivity in the instantaneous RF bandwidth from the nature of atomic transitions at each frequency choice, and the frequency-independent size of the sensor head. Applications of these sensors include SI-traceable E-field probes, voltage standards, power sensors, microwave radiometers, direction of arrival estimation, radar and communication receivers with amplitude, frequency, and phase modulated signal discrimination, and many others. This workshop will give an overview and summarize this new technology, discuss various applications, and pathways to commercialization.</td>
</tr>
</tbody>
</table>
RF BOOT CAMP

This one-day course is ideal for newcomers to the microwave world, such as technicians, new engineers, college students, engineers changing their career paths, as well as marketing and sales professionals looking to become more comfortable in customer interactions involving RF and Microwave circuit and system concepts and terminology.

The format of the RF Boot Camp is similar to that of a workshop or short course, with multiple presenters from industry and academia presenting on a variety of topics including:

- The RF/Microwave Signal Chain
- Network Characteristics, Analysis and Measurement
- Fundamentals of RF Simulation
- Impedance Matching Basics
- Spectral Analysis and Receiver Technology
- Signal Generation
- Modulation and Vector Signal Analysis
- Microwave Antenna Basics
- RFMW Application Focus

This full-day course will cover real-world, practical, modern design and engineering fundamentals needed by technicians, new engineers, engineers wanting a refresh, college students, as well as marketing and sales professionals. Experts within industry and academia will share their knowledge of: RF/Microwave systems basics, simulation and network design, network and spectrum analysis, microwave antenna and radar basics. Attendees completing the course will earn 2 CEUs. Course outline and speaker bios can be found at ims-ieee.org and on the mobile app.

IEEE FELLOWS

CLASS OF 2022

THE IEEE GRADE OF FELLOW is conferred by the Board of Directors upon a person with an extraordinary record of accomplishments in any of the IEEE fields of interest. The total number selected in any one year does not exceed one-tenth of one percent of the total voting Institute membership. The accomplishments that are being honored have contributed importantly to the advancement or application of engineering, science and technology, bringing the realization of significant value to society. Fellow grade is effective 1 January 2022. Fellows will be recognized at the IMS Plenary Session tonight at 17:30-19:00 in the Four Seasons Ballroom.

EVALUATED BY MTT-S

Dominique Baillargeat  for contributions to developments of nanomaterials for RF packaging and sensors
James Buckwalter  for contributions to high-efficiency millimeter-wave power amplifiers and optical transceivers in SOI technologies
Wenquan Che  for contributions to planar transmission line structures for microwave passive components
Alessandra Costanzo  for contributions to nonlinear electromagnetic co-design of RF and microwave circuits
Apostolos Georgiadis  for contributions to designs of RF energy harvesting circuits
Jeffrey Hesler  for contributions to development of terahertz components and instrumentation
Slawomir Koziel  for contributions to modeling and optimization of microwave devices and circuits
Moriyasu Miyazaki  for leadership in developments of airborne active-phased-array radars and satellite communication microwave subsystems
Anh-Vu Pham  for contribution to organic packaging technologies
Christopher Rodenbeck  for contributions to radar microsystems for ultrawideband and millimeter-wave applications
Daniel van der Wiede  for contributions to ultrafast terahertz electronics and biomedical applications of microwave technologies
Christian Waldschmidt  for contributions to millimeter wave automotive radar sensors
Anding Zhu  for contributions to behavioral modeling and digital predistortion of RF power amplifiers

EVALUATED BY OTHER IEEE SOCIETIES/COUNCILS

Hongsheng Chen  for contributions to electromagnetic metamaterial and invisibility cloak
Tommaso Isernia  for contributions on antennas synthesis and inverse scattering problems
Mikko Valkama  for contributions to physical layer signal processing in radio systems
Xiuyin Zhang  for contributions to the design of filtering antennas
Jiang Zhu  for contributions to antenna design for wireless communications
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**Abstract:**

This panel debates the roles of academia and industry in shaping the future of RFIC design. Given the increased complexity of modern RF integrated systems and the need for well trained RFIC engineers, the panel raises the question of who should lead RFIC research. If the industry is to take the lead, what is the role of universities and who should pay for training graduate students? Should academics move to other research domains? What should be done to prevent them from being lured away from universities and into financially rewarding industry careers? Are there fundamental RFIC research challenges that academics can still tackle for the next generation RF systems given the increasing complexities in design and fabrication of advanced RFICs?

The panel, formed of industry experts, university professors and those who crossed the line between academic and industry careers, will look at past, current and future RFIC research, education, and support models with the audience’s participation.

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**TL2**

**Electromagnetic Fundamentals Underlying Health Impact of Millimeter-Wave Radiations**

**Speaker:** Abbas Omar, Univ. of Magdeburg

Millimeter Wave mobile communication (5G and beyond) has been 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 a few millimeters. 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.

This Technical Lecture aims to comprehensively review the relevant electromagnetic fundamentals underlying the wave-matter interaction involved in any eventual health hazard which might be associated with millimeter-wave radiation. Basic related aspects include the following:

- **Direct health hazards** must involve either chemical reactions or thermal/mechanical destruction of cells/tissues. This must be accompanied by energy transfer from the electromagnetic wave to the biological substances.
- **Indirect hazards** include overloading the biological mechanisms involved in the body thermoregulation.
- **Thermal effects** involve rise of temperature, an increase in the magnitude of atomic/molecular lattice vibrations. Chemical reactions (e.g., burning) will only occur if the temperature increase exceeds a certain limit. Otherwise, the rise is reversible, regulated to steady state by the blood circulation within the body.
- **Non-ionizing waves** are wavelengths that are much larger than the atomic/molecular scale, a continuous spatial distribution of the 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). Millimeter Waves and even Tera-Hertz Waves belong to this category.
- **Ionizing radiation** has wavelengths comparable to the interatomic or intermolecular spaces and an electromagnetic wave quantization approach makes sense. Wave-matter interactions can be explained using the discrete representation of the waves, photons, which are ensembles of energy packages highly localized in time and space. A single photon carries energy proportional to its frequency which, e.g., can be fully transferred to and result in electrical destruction of a molecular bond. Ionizing radiation only occurs at frequencies much higher than that of ultraviolet light and therefore is not applicable to the millimeter-wave case.
- **Use of a photon representation to describe Millimeter Waves** would require the photon spatial extent to be of the same order of magnitude as the wavelength and a photon collision would necessarily involve millions of atoms/molecules (as if swimming in it). A single chemical bond could not absorb the entire photon energy.
In its sixth year, the IMS2022 3MT competition is designed to stimulate interest in the wide range of applications of microwave technology. Contestants will make a presentation of three minutes or less, supported only by one static slide, in a language appropriate to a non-specialist audience. The winners of the 3MT competition will receive their prizes at the IMS2022 Closing Session on Thursday, 23 June 2022.

**ORGANIZERS/CO-CHAIRS:** John Bandler, Senior Advisor

Aline Eid, 2022 3MT® Co-Chair

Jimmy Hester, 2022 3MT® Co-Chair

Erin Kiley, Member

Daniel Tajik, Member

**THIS YEAR’S FINALISTS ARE:**

- **Which Way Is Up?**
  
  *Tu1C-1* Ajibayo Adeyeye, Georgia Institute of Technology

- **You Are Close! Set Sail with the Crew SYNC.**
  
  *We1D* Víctor Ángel Ardila Acuña, Universidad de Cantabria

- **Automotive Radars: It’s the Journey that Matters, Not the Destination.**
  
  *RMo4C* Ioanna Apostolina, Univ. of Pavia

- **Lowest Rate Operations at the Spectral “Beach Front Property”**
  
  *Th2B-4* Gokhan Ariturk, Univ. of Oklahoma

- **Cool it! Minimizing Noise in Microwave Readout Amplifiers**
  
  *Tu3E-3* Shai Bonen, Univ. of Toronto

- **Making Cyclists Visible: A Safety Vest for Microwaves.**
  
  *We2F-2* Tobias T. Braun, Ruhr Univ. Bochum

- **Integrable Energy Harvesting**
  
  *Tu3C-2* Nathan Chordas-Ewell, SUNY Buffalo

- ** Saving Your Battery Life**
  
  *We1E-2* Chenhao Chu, Univ. College Dublin

- **Low-Power Electronics for Future Quantum Computers.**
  
  *We4D-2* Sayan Das, Univ. of Massachusetts, Amherst

- **Overcoming a World Without Translators**
  
  *Th2A-2* Ricardo Figueiredo, Universidade de Aveiro

- **Safer Intersections for Our Phones**
  
  *Tu4B-1* Alden Fisher, Purdue Univ.

- **Towards Detecting EM Attack on Silicon ICs by Simple On-chip Circuit Components**
  
  *We3C-3* Archisman Ghosh, Purdue Univ.

- **Efficient THz Generator**
  
  *TUIF1-8* Alexander Possberg, Univ. of Duisburg-Essen

- **More Than Just Noise—Making Bits Fly**
  
  *Tu4D-3* Florian Probst, Friedrich-Alexander-Universität Erlangen-Nürnberg

- **Ultrafast Optical Analysis Tool for Microwave Signals**
  
  *Th1C-4* Connor Rowe, Institut National de la Recherche Scientifique

- **Detective Microwave in Pursuit of Any Microplastic Clue**
  
  *Tu4B-4* Maziar ShafieiDarabi, Univ. of Waterloo

- **Flexible Electronics Help Our World Lose Weight**
  
  *WE1F2-3* Xiaolin Wang, Tokyo Institute of Technology

- **Using Quantum Computing to Solve Large Electromagnetic Equations**
  
  *TUIF1-3* Louis Zhang, Univ. of Toronto

- **Digital mmWave Radar, the Infrastructure of the Digital Era**
  
  *Mo3A-4* Wen Zhou, Univ. of Minnesota
**IMS INDUSTRY SHOWCASE**

**16:00 – 17:30**

**Monday, 20 June 2022**

**Mile High Ballroom Pre-Function Space**

Join us before the IMS Plenary Session for the Industry Showcase where selected speakers will present their work.

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<th>SPEAKER</th>
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<td>Mikael Horberg, Ericsson</td>
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<td>Fast Simultaneous Characterization of all Analog Phased Array Elements</td>
<td>Michael Foegelle, ETS-Lindgren</td>
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<td>15 to 72 GHz Closed-Loop Impairment Corrected mm-Wave Delay_5002_ Locked IQ Modulator for 5G Applications</td>
<td>Isaac Martinez, Keysight Technologies</td>
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<td>Dynamically Reconfigurable Metasurface Antennas for Mobile Connectivity in 5G Non-Terrestrial Networks</td>
<td>Ryan Stevenson, Kymeta Corporation</td>
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<td>Rydberg Atom Electrometry: a Near-Field Technology for Complete Far-Field Imaging in Seconds</td>
<td>James Shaffer, Quantum Valley Ideas Laboratory</td>
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<td>A 1024-Element Ku-Band SATCOM Phased-Array Transmitter With 39.2-dBW EIRP and ± 53o beam scanning</td>
<td>Jui-Hung Chou, Rapidtek</td>
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<td>Multi-channel Schottky-gate BRIDGE HEMT Technology for Millimeter-Wave Power Amplifier Applications</td>
<td>Keisuke Shinohara, Teledyne Scientific</td>
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<td>A Fully-Integrated CMOS System-on-Chip Ku Band Radiometer System for Remote Sensing of Snow and Ice</td>
<td>Adrian Tang, UCLA/JPL</td>
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**IMS PLENARY SESSION**

**17:30 – 19:00**

**Monday, 20 June 2022**

**Four Seasons Ballroom**

**A Quantum Technology Landscape**

**IMS KEYNOTE SPEAKER:**

Prof. Dana Z. Anderson, *ColdQuanta, Inc.* and *The JILA Institute & Dept. of Physics, Univ. of Colorado*

**ABSTRACT:** The revolution promised by quantum computing sits on the horizon but in fact is just one of many ‘revolutions’ that will be enabled by quantum technologies. Extracting quantum behavior typically means working with systems that are cold: a millionth of a degree above absolute zero temperature might seem terribly cold, but it is now routinely achieved with ensembles of atoms using laser cooling and related techniques. Clocks utilizing ultracold atoms have demonstrated performance that is more than 10,000 times more precise than today’s world timekeepers. Consider timekeeping as the harbinger of more quantum things to come —technology poised to impact timekeeping, sensing, communications, networking, in addition to computing. This talk centers specifically on quantum technology based on atoms, whose quantum character is being utilized in electromagnetic field detection (particularly RF), inertial sensing for navigation, and numerous other applications, not to mention new devices, such as the atomtronic transistor. This talk will emphasize the critical need for microwave engineering to design and control these new quantum-enhanced circuits. One hears a lot about “quantum” these days: I will explain many of the commonly used terminology such as “superposition” and “entanglement” to describe what is meant by the phrase “quantum advantage” in practical terms.

**BIOGRAPHY:** Prof. Dana Z. Anderson received his Ph.D. in quantum optics working under Prof. Marlan Scully. His thesis research centered on fundamental principles of ring laser gyroscopes. As a postdoctoral fellow at Caltech he carried out work on the prototype laser interferometer gravitational observatory (LIGO). He is currently a Fellow of the JILA Institute at the University of Colorado and a Professor of the Department of Physics and the Department of Electrical, Computer and Energy Engineering at the University. He is an applied physicist working in the areas of quantum optics, atomic physics, and precision measurement. His research includes the development of atom based inertial sensors, quantum communications systems, quantum computing, quantum emulators, and atomtronics (the atom analog of electronics). Prof. Anderson has published over 100 refereed papers, holds several patents, and has received several awards including a Presidential Young Investigator award, a Sloan Foundation Fellowship, a Humboldt Research Award, the Optical Society of America’s R.W. Wood Prize for his pioneering work on optical neural networks, the CO-LABS Governor’s Award for foundational contributions ultracold matter technology, and the Willis Lamb Prize for Excellence in Quantum Optics and Electronics. Prof. Anderson is also Founder and CTO of ColdQuanta, Inc., a company that develops and manufactures cold and ultracold matter-based quantum technology covering a broad spectrum of systems, from clocks to quantum computers, including a system currently operating on the International Space Station under NASA’s Cold Atom Laboratory (CAL) mission.
Space, Changing the Way We Live, Enabled by Microwave Innovations

IMS KEYNOTE SPEAKER:

Gregory E. Edlund, Lockheed Martin Space Systems Company

ABSTRACT: Space is becoming the high ground for many missions and applications that are revolutionizing the way we live. The space industry is in the midst of dramatic advancement of applications, markets, and demand supporting global situational awareness (including weather, climate and earth science), communications, missile defense, positioning navigation and timing, and exploration. This mandates small, low weight, low power consumption electronics, with a continual push for lower cost and reduced development and test schedules. For this unprecedented challenge, Lockheed Martin is introducing next generation space vehicles and payloads that include advanced multi-beam Electronically Steerable Arrays (ESA), multi-channel System-in-Package (SIP) and signal-processing RF units accentuated with flexible, advanced digital signal processors. Microwave engineering is at the forefront of these applications and this talk will address the challenges associated with operating in the harsh environment of space and the development and testing of custom MMICs and new RF Photonic Integrated circuits to support these applications.

BIOGRAPHY: Greg Edlund is the Vice President and Chief Architect at Lockheed Martin Space Systems Company. He is responsible for understanding the mission priorities and industry landscape to set the vision and strategy for enterprise subsystem and product roadmaps. Prior to his current role Greg led the RF Payload Center of Excellence at Lockheed Martin Space Systems Company. Greg brings over 38 years of leadership and experience working at The Aerospace Corporation, as an independent Consultant, at Northrop Grumman, and at Lockheed Martin. Prior to Lockheed Martin he was with Northrop Grumman Aerospace Systems where he worked in program management, new business, and engineering space solutions across DoD, commercial, civil and restricted efforts. He also supported integrated air/space solutions, and the development and execution of several airborne platforms.

Prior to Northrop Grumman, Greg worked as an independent consultant developing business and capture strategies for Commercial, Military and Restricted space business areas. Greg also consulted with the US government focused on advancing the future DoD, civil and restricted communications architectures and specifically the initiation of the TSAT program. Greg started his career with The Aerospace Corporation, where he supported the DoD, civil and national space programs. He managed the MILSATCOM advanced plans group, a communications subdivision directorate and opened The Aerospace Corporation’s Washington, DC Field Office.
## RFIC Technical Sessions 08:00 – 09:40

**Tuesday, 21 June 2022**

**Colorado Convention Center**

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<th>Time</th>
<th>Session</th>
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<td><strong>08:00</strong></td>
<td>1A-1C</td>
<td>RTu1A: mm-Wave and Wide Band Low-Noise CMOS Amplifiers</td>
<td>Chair: Hao Gao, Silicon Austria Labs, Austria  Co-Chair: Marcus Granger-Jones, Qorvo, USA</td>
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<td><strong>08:20</strong></td>
<td>RTu1A-1: 28GHz Compact LNAs with 1.9dB NF Using Folded Three-Coil Transformer and Dual-Feedforward Techniques in 65nm CMOS</td>
<td>X. Huang, Tsinghua Univ.; H. Jia, Tsinghua Univ.; W. Deng, Tsinghua Univ.; Z. Wang, RITS; B. Chi, Tsinghua Univ.</td>
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<tr>
<td><strong>08:40</strong></td>
<td>RTu1A-2: 22–33GHz CMOS LNA Using Coupled-TL Feedback and Self-Body Forward-Bias for 28GHz 5G System</td>
<td>Y.-S. Lin, National Chi Nan Univ.; K.-S. Lan, National Chi Nan Univ.</td>
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<tr>
<td><strong>09:00</strong></td>
<td>RTu1A-3: A Capacitor Assisting Triple-Winding Transformer Low-Noise Amplifier with 0.8–1.5dB NF 6–12GHz BW ±0.75dB Ripple in 130nm SOI CMOS</td>
<td>T. Zou, Fudan Univ.; H. Xu, Fudan Univ.; Y. Wang, Fudan Univ.; W. Liu, Fudan Univ.; T. Han, CASIC IT Academy; Z. Wang, Archwave Microelectronics; N. Li, Archwave Microelectronics; M. Tian, CASIC IT Academy; W. Zhu, CASIC IT Academy; N. Yan, Fudan Univ.</td>
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<td><strong>09:20</strong></td>
<td>RTu1A-4: An LNA with Input Power Match from 6.1 to 38.6GHz, the Noise-Figure Minimum of 1.9dB, and Employing Back Gate for Matching</td>
<td>M. Radpour, Univ. of Calgary; L. Belostotski, Univ. of Calgary</td>
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<tr>
<td><strong>09:40</strong></td>
<td><strong>1D-1F</strong></td>
<td>RTu1B: Efficiency Enhancement Techniques for Power Amplifiers</td>
<td>Chair: SungWon Chung, Neuralink, USA  Co-Chair: Alexandre Giry, CEA-LETI, France</td>
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<td><strong>08:00</strong></td>
<td>RTu1B-1: A 38GHz Deep Back-Off Efficiency Enhancement PA with Three-Way Doherty Network Synthesis Achieving 11.3dBm Average Output Power and 14.7% Average Efficiency for 5G NR OFDM</td>
<td>X. Zhang, Rice Univ.; S. Li, Samsung; D. Huang, Samsung; T. Chi, Rice Univ.</td>
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<tr>
<td><strong>08:20</strong></td>
<td>RTu1B-2: A Polar Doherty SCPA with 4.4° AM-PM Distortion Using On-Chip Self-Calibration Supporting 64-/256-/1024-QAM</td>
<td>H. Tang, UESTC; H.J. Qian, UESTC; B. Yang, UESTC; T. Wang, UESTC; X. Luo, UESTC</td>
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<tr>
<td><strong>08:40</strong></td>
<td>RTu1B-3: A Compact Single Transformer Footprint Hybrid Current-Voltage Digital Doherty Power Amplifier</td>
<td>J. Lee, Georgia Tech; D. Jung, Georgia Tech; D. Munzer, Georgia Tech; H. Wang, Georgia Tech</td>
<td></td>
</tr>
<tr>
<td><strong>09:00</strong></td>
<td>RTu1B-4: An Eight-Core Class-G Switched-Capacitor Power Amplifier with Eight Power Backoff Efficiency Peaks</td>
<td>B. Qiao, Oregon State Univ.; A.V. Kayyil, Oregon State Univ.; D.J. Allstot, Oregon State Univ.</td>
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**JOIN US FOR Sweet Treat Tuesday AT 12:00!**

Enjoy a “Sweet Treat” in the company of attendees, exhibitors, and colleagues on the IMS Show Floor.

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**RFIC Technical Sessions**

**08:00 – 09:40**

**Tuesday, 21 June 2022**

**Colorado Convention Center**

**1A-1C**

**RTu1A: mm-Wave and Wide Band Low-Noise CMOS Amplifiers**

- **Chair:** Hao Gao, Silicon Austria Labs, Austria
- **Co-Chair:** Marcus Granger-Jones, Qorvo, USA

**RTu1A-1: 28GHz Compact LNAs with 1.9dB NF Using Folded Three-Coil Transformer and Dual-Feedforward Techniques in 65nm CMOS**

X. Huang, Tsinghua Univ.; H. Jia, Tsinghua Univ.; W. Deng, Tsinghua Univ.; Z. Wang, RITS; B. Chi, Tsinghua Univ.

**RTu1A-2: 22–33GHz CMOS LNA Using Coupled-TL Feedback and Self-Body Forward-Bias for 28GHz 5G System**

Y.-S. Lin, National Chi Nan Univ.; K.-S. Lan, National Chi Nan Univ.

**RTu1A-3: A Capacitor Assisting Triple-Winding Transformer Low-Noise Amplifier with 0.8–1.5dB NF 6–12GHz BW ±0.75dB Ripple in 130nm SOI CMOS**

T. Zou, Fudan Univ.; H. Xu, Fudan Univ.; Y. Wang, Fudan Univ.; W. Liu, Fudan Univ.; T. Han, CASIC IT Academy; Z. Wang, Archwave Microelectronics; N. Li, Archwave Microelectronics; M. Tian, CASIC IT Academy; W. Zhu, CASIC IT Academy; N. Yan, Fudan Univ.

**RTu1A-4: An LNA with Input Power Match from 6.1 to 38.6GHz, the Noise-Figure Minimum of 1.9dB, and Employing Back Gate for Matching**

M. Radpour, Univ. of Calgary; L. Belostotski, Univ. of Calgary

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**1D-1F**

**RTu1B: Efficiency Enhancement Techniques for Power Amplifiers**

- **Chair:** SungWon Chung, Neuralink, USA
- **Co-Chair:** Alexandre Giry, CEA-LETI, France

**RTu1B-1: A 38GHz Deep Back-Off Efficiency Enhancement PA with Three-Way Doherty Network Synthesis Achieving 11.3dBm Average Output Power and 14.7% Average Efficiency for 5G NR OFDM**

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**RTu1B-2: A Polar Doherty SCPA with 4.4° AM-PM Distortion Using On-Chip Self-Calibration Supporting 64-/256-/1024-QAM**

H. Tang, UESTC; H.J. Qian, UESTC; B. Yang, UESTC; T. Wang, UESTC; X. Luo, UESTC

**RTu1B-3: A Compact Single Transformer Footprint Hybrid Current-Voltage Digital Doherty Power Amplifier**

J. Lee, Georgia Tech; D. Jung, Georgia Tech; D. Munzer, Georgia Tech; H. Wang, Georgia Tech

**RTu1B-4: An Eight-Core Class-G Switched-Capacitor Power Amplifier with Eight Power Backoff Efficiency Peaks**

B. Qiao, Oregon State Univ.; A.V. Kayyil, Oregon State Univ.; D.J. Allstot, Oregon State Univ.

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**JOIN US FOR Sweet Treat Tuesday AT 12:00!**

Enjoy a “Sweet Treat” in the company of attendees, exhibitors, and colleagues on the IMS Show Floor.

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NEW FOR IMS2022! THE SYSTEMS FORUM

A New Initiative at IMS2022 Highlighting MTT Activities of Interest to System Engineers

- Additional outlet for system-level research
- Tap into areas of local activity (Denver: defense, 5G/6G, quantum, phased arrays, etc.)
- Draw in additional participants

The Systems Forum will overlay the regular technical program by arranging technical content along thematic “Days:”

### Activities will be related to the thematic topic areas

- Panel Sessions
- Focus Sessions
- IEEE Microwave Magazine overview papers
- Interactive Forum Plenary Posters with well-known presenters
- Receptions

A small gear symbol on an activity denotes it is part of the Systems Forum.

Systems Forum activities by day are shown below.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Tuesday June 21</th>
<th>Wednesday June 22</th>
<th>Thursday June 23</th>
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</thead>
<tbody>
<tr>
<td><strong>Conn. Future Summit</strong></td>
<td><strong>Quantum Systems Day</strong></td>
<td><strong>Radar &amp; Aerospace Day</strong></td>
<td><strong>Phased Arrays &amp; OTA Day</strong></td>
</tr>
<tr>
<td>AM1: 08:00-09:40</td>
<td><strong>Keynote:</strong> Smart Cities and Our Connected Future</td>
<td><strong>Keynote:</strong> Engineering Quantum Systems of Superconducting Qubits</td>
<td><strong>Keynote:</strong> Recent Radar Advances and Their Impact</td>
</tr>
<tr>
<td>AM2: 10:10-11:50</td>
<td><strong>Session 1:</strong> The Connected Future</td>
<td><strong>Tu1E Focus Session:</strong> Microwave Technologies for Quantum-System Integration</td>
<td><strong>We1F Focus Session:</strong> Radar from Space to Ground (and below) - The synergy between commercial, government, and metrology applications</td>
</tr>
<tr>
<td>Lunch 12:00-13:30</td>
<td><strong>Session 2:</strong> Spectrum, Standards and Innovation</td>
<td><strong>Tu2E Focus Session:</strong> Cryogenic Microwave Circuits for Control of Quantum Systems</td>
<td><strong>Tu2F:</strong> Advanced Concepts for 77 GHz Radar</td>
</tr>
<tr>
<td>PM1: 13:30-15:10</td>
<td><strong>Panel Session w/RCIC:</strong> Race to the Next G – Ride the mmWave or Wave Goodbye!</td>
<td><strong>Panel Session:</strong> This is the Right Way to Architect the Microwave Control for a Quantum Computer and Constellations: Who Will be the Winners of the New Race to Space?</td>
<td><strong>Th1F Focus Session w/ARFTG:</strong> Efficient Characterization and Test of Phased Array</td>
</tr>
<tr>
<td>PM2: 16:40-17:00</td>
<td><strong>Session 3:</strong> Next-Generation Technologies</td>
<td><strong>Tu3E Focus Session:</strong> Cryogenic Measurement and Characterization for Quantum Information Systems</td>
<td><strong>We3F Focus Session:</strong> Cognitive Radar</td>
</tr>
<tr>
<td>Session 4: 6G Challenges</td>
<td><strong>Panel Session:</strong> “Will flexibility and digital bottlenecks break 6G?” Connected Future Summit Reception (17:00-17:45)</td>
<td><strong>We4F:</strong> Advanced Radar Imaging and Signal Processing</td>
<td><strong>Phased Arrays and OTA Reception at the Interactive Forum:</strong> Plenary Poster, Phased Array Posters</td>
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**imas2022 Closing Session**
### IMS TECHNICAL SESSIONS

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<th>Session</th>
<th>Title</th>
<th>Authors</th>
<th>Contact</th>
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<tbody>
<tr>
<td>08:00 - 09:40</td>
<td>Passive Components</td>
<td>Tu1A: Advances in Synthesis and Design Techniques for Non-Planar Filters</td>
<td>Chair: Simone Bastioli, RS Microwave</td>
<td>Bastioli, S. (RS Microwave)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Co-Chair: Antonio Morini, Politecnica delle Marche</td>
<td>Morini, A. (Politecnica delle Marche)</td>
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<tr>
<td></td>
<td></td>
<td>Tu1A-1: New Triple-Resonance Configurations Using Stubbed Waveguide Dual-Mode Cavities</td>
<td>Simone Bastioli, RS Microwave; Richard Snyder, RS Microwave</td>
<td>Bastioli, S. (RS Microwave); Snyder, R. (RS Microwave)</td>
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<td></td>
<td>401-402</td>
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<tr>
<td></td>
<td>Passive Components</td>
<td>Tu1B: Advances in Numerical and Computational Techniques for Simulation and Design Optimization Dedicated to Tapan Sarkar</td>
<td>Chair: Ern Kiley, Massachusetts College of Liberal Arts</td>
<td>Kiley, E. (Massachusetts College of Liberal Arts)</td>
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<tr>
<td></td>
<td></td>
<td>Co-Chair: José E. Rayas-Sánchez, IESPE</td>
<td>Rayas-Sánchez, J. E. (IESPE)</td>
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<td></td>
<td></td>
<td>Tu1B-1: Electromagnetic Time Kurtosis for Time-Reversal Source Reconstruction with Band-Limited Signals</td>
<td>X.-Y. Feng, Dalhousie Univ.; Z. Chen, Fuzhou Univ.; J. Li, Fuzhou Univ.; J. Cai, Fuzhou Univ.; J.-C. Liang, Southeast Univ.</td>
<td>Feng, X.-Y. (Dalhousie Univ.); Chen, Z. (Fuzhou Univ.); Li, J. (Fuzhou Univ.); Cai, J. (Fuzhou Univ.); Liang, J.-C. (Southeast Univ.)</td>
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<td></td>
<td>Passive Components</td>
<td>Tu1C: Advances in RFID Technologies</td>
<td>Chair: Victor M. Lubecke, Univ. of Hawaii at Manoa</td>
<td>Lubecke, V. M. (Univ. of Hawaii at Manoa)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Co-Chair: Alessandra Costanzo, Università di Bologna</td>
<td>Costanzo, A. (Università di Bologna)</td>
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<tr>
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<td>Tu1C-1: Ultra-Range Dual Rotman Lenses-Based Harmonic mixer’s for 5G/mm-Wave IoT Applications</td>
<td>C.A. Lynch III, Georgia Tech; A. Adevyeye, Georgia Tech; A. Ezid, Georgia Tech; J. Hester, Aetheraxon; M.M. Tentzeris, Georgia Tech</td>
<td>Lynch III, C.A. (Georgia Tech); Adevyeye, A. (Georgia Tech); Ezid, A. (Georgia Tech); Hester, J. (Aetheraxon); Tentzeris, M.M. (Georgia Tech)</td>
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<td>501-502</td>
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<td></td>
<td>Passive Components</td>
<td>Tu1D: Advanced Frequency Synthesis</td>
<td>Chair: Amit Jha, Qualcomm</td>
<td>Jha, A. (Qualcomm)</td>
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<td>Co-Chair: Jahnnavi Sharma, Intel</td>
<td>Sharma, J. (Intel)</td>
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<td>Tu1D-3: A W-Band Wide Locking Range Divide-by-Three Injection-Locked Frequency Divider in 40nm CMOS</td>
<td>W.-C. Chang, National Tsing Hua Univ.; H.-C. Chang, National Tsing Hua Univ.; F.-C. Chang, National Tsing Hua Univ.; J.Y.-C. Liu, National Tsing Hua Univ.</td>
<td>Chang, W.-C. (National Tsing Hua Univ.); Chang, H.-C. (National Tsing Hua Univ.); Chang, F.-C. (National Tsing Hua Univ.); Liu, J.Y.-C. (National Tsing Hua Univ.)</td>
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<td></td>
<td>Passive Components</td>
<td>Tu1D-4: A Hybrid Pulling Mitigation Synthesizer for NB-IoT Transmitter</td>
<td>N. Mahalingam, SUTD; H. Liu, SUTD; Y. Wang, SUTD; K.S. Yeo, SUTD; C.-I. Chou, Realtek Semiconductor; H.-Y. Tsai, Realtek Semiconductor; K.-H. Liao, Realtek Semiconductor; K.-U. Wang, Realtek Semiconductor; K.-U. Lin, Realtek Semiconductor</td>
<td>Mahalingam, N. (SUTD); Liu, H. (SUTD); Wang, Y. (SUTD); Yeo, K.S. (SUTD); Chou, C.-I. (Realtek Semiconductor); Tsai, H.-Y. (Realtek Semiconductor); Liao, K.-H. (Realtek Semiconductor); Wang, K.-U. (Realtek Semiconductor); Lin, K.-U. (Realtek Semiconductor)</td>
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</table>
Tu1E: Microwave Technologies for Quantum-System Integration
Chair: Nizar Messaoudi, Keysight Technologies
Co-Chair: Sorin P. Voinigescu, Univ. of Toronto

Tu1E-1: Keynote: Engineering Quantum Systems of Superconducting Qubits
William Oliver, Massachusetts Institute of Technology

Tu1E-2: Superconducting Microwave Interconnect Technologies for Quantum and Cryogenic Systems

Tu1E-3: Prospects for Parametric Amplifiers in Large-Scale Superconducting Quantum Computing
J. Aumentado, NIST

Tu1E-4: High-Fidelity RF/Microwave-Based Universal Control of Trapped Ion Qubits
R. Srinivas, NIST; S.C. Burd, NIST; H.M. Knaack, NIST; R.I. Sutherland, LLNL; A. Kawatkowski, NIST; S. Glancy, NIST; E. Krill, NIST; D.J. Wineland, NIST; D. Leibfried, NIST; A.C. Wilson, NIST; D.T.C. Alcock, NIST; D.H. Slichter, NIST

The snowball effect of the COVID-19 pandemic has led to an alarming global shortage of integrated circuits chips and severe disruptions in almost any product that relies on the semiconductor supply chain. On the other hand, we have witnessed radically increasing public attention and government/industry investments on semiconductor technologies, as demonstrated by the CHIPS Act in the EU and USA. While the semiconductor industry may envision an explosive growth in the next decade, tech industry leaders are struggling to attract and retain talent.

This student panel event invites industry leaders to present the new technology trends in the semiconductor industry and their Big-Picture visions related to RFICs. The purpose of this student panel is to educate graduate and undergraduate students about the RF semiconductor industry and encourage them to join the fast-growing field of RFICs.

Student Industry CHIPS Forum
ORGANIZER: Jennifer Kitchen, Arizona State Univ.

PANELISTS:
Alessandro Piovaccari, Universit. di Bologna; Gary Xu, Samsung Research America; Jeremy Dunworth, Qualcomm; Andrea Cathelin, STMicroelectronics; Shahriar Shahramian, Nokia Bell Labs; Nadine Collaert, imec

Student Entrepreneurship Forum
ORGANIZER: Vadim Issakov, Technische Universität Braunschweig

PANELISTS:
Arun Natarajan, MixComm; Bogdan Staszewski, Equal1; Patrick Chiang, PhotonIC Technologies; Yang Xu, InnoPhase; Wouter Stoyaert, Tusk IC

Startup companies emerging from cutting-edge academic research have always been an integral component of the semiconductor industry and its continuous growth. However, to many students, there is lack of education on entrepreneurship careers and what it takes to achieve a successful semiconductor startup company.

This student panel invites entrepreneurs in our RFIC community to share their startup experiences and stories. The purpose is to educate graduate students regarding entrepreneurship in the RFIC field and its associated challenges and opportunities.
<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Title</th>
<th>Authors</th>
<th>Affiliations</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:10</td>
<td>Tu2A1</td>
<td>Dual-Pol Quadruple Ridge Resonator Filter with Transmission Zeros</td>
<td>M.A. Fuentes Pascual, Univ. Politécnica de Valencia; M. Guglielmi, Univ. Politécnica de Valencia; V.E. Boria, Univ. Politécnica de Valencia; M. Baquero-Escudero, Univ. Politécnica de Valencia</td>
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<tr>
<td>10:20</td>
<td>Tu2A2</td>
<td>Dual-Band Filters Based on Dual-Mode Ellipsoidal Cavities</td>
<td>E. López-Oliver, Università di Perugia; C. Tomassoni, Università di Perugia</td>
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</tr>
<tr>
<td>10:30</td>
<td>Tu2A3</td>
<td>Compact Ultra-Wideband Cavity Filter Based on Suspended Ceramic Resonators in Additive Manufacturing</td>
<td>P. Vallerotonda, RF Microtech; F. Cacciamani, RF Microtech; L. Pelliccia, RF Microtech; C. Tomassoni, Università di Perugia; G. Cannone, SIAE MICROELETTRONICA; V. Tornielli di Perugia; A. Zaccari, Politecnico di Milano</td>
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<tr>
<td>10:40</td>
<td>Tu2A4</td>
<td>3D-Printed Compact Waveguide Filters Based on Slanted Ridge Resonators</td>
<td>F. Romano, Università di Pavia; N. Delmonte, Università di Pavia; C. Tomassoni, Università di Perugia; L. Perregni, Università di Pavia; M. Bozi, Università di Pavia</td>
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<tr>
<td>10:50</td>
<td>Tu2B1</td>
<td>The Synergy Between Optimization and Time Domain Electromagnetics, Evolution and Future Possibilities</td>
<td>W.J.R. Hofer, Univ. of Victoria</td>
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<tr>
<td>11:00</td>
<td>Tu2B2</td>
<td>Analytical Expressions for Field-based Response Sensitivity</td>
<td>Natalia Nikolaeva, McMaster Univ.; Romina Kazemivala, McMaster Univ.</td>
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</tr>
<tr>
<td>11:10</td>
<td>Tu2B3</td>
<td>EM-Driven Tolerance Optimization of Compact Microwave Components Using Response Feature Surrogates</td>
<td>A. Pietrenko-Dobrowska, Gdańsk Univ. of Technology; S. Kozieł, Rzeszów Univ.; J.W. Bandler, McMaster Univ.; J.E. Rayas-Sánchez, IESO</td>
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<tr>
<td>11:20</td>
<td>Tu2B4</td>
<td>Surrogate-Based Design and Tuning Methods for RF/Microwave Devices</td>
<td>Y. Yu, SUSTech; Z. Zhang, SUSTech; Q.S. Cheng, SUSTech; B. Liu, Univ. of Glasgow; Y. Wang, Univ. of Birmingham</td>
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<tr>
<td>11:30</td>
<td>Tu2B5</td>
<td>Recent Advances and Future Trends in Neuro-TF for EM Optimization</td>
<td>F. Feng, Tianjin Univ.; Q. Guo, Tianjin Univ.; Q.-J. Zhang, Carleton Univ.</td>
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<tr>
<td>11:50</td>
<td>Tu2B7</td>
<td>Recent Advances on Aggressive Space Mapping Techniques for Waveguide Filters Design and Tuning</td>
<td>J.C. Melgarejo, Univ. Politécnica de Valencia; J. Ossorio, Univ. Politécnica de Valencia; D. Rubio, Univ. Politécnica de Valencia; S. Cogollos, Univ. Politécnica de Valencia; M. Guglielmi, Univ. Politécnica de Valencia; V.E. Boria, Univ. Politécnica de Valencia</td>
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<tr>
<td>12:00</td>
<td>Tu2C1</td>
<td>A Retrospective and a Vision of Future Trends in RF and Microwave Design Optimization Dedicated to Vittorio Rizzoli</td>
<td>J. Liu, SJTU; F. Tong, SJTU; C. Gu, SJTU; J. Mao, SJTU</td>
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<tr>
<td>12:10</td>
<td>Tu2C2</td>
<td>A Noise-Immune Motion Sensing Technique with Low-IF CW Radars</td>
<td>J. Liu, SJTU; F. Tong, SJTU; C. Gu, SJTU; J. Mao, SJTU</td>
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<tr>
<td>12:20</td>
<td>Tu2C3</td>
<td>Vibration Sensing Using Doppler-Modulated Chipless RFID Tags</td>
<td>A. Azarfar, LCIS (EA 3747); N. Barbot, LCIS (EA 3747); E. Perret, LCIS (EA 3747)</td>
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<tr>
<td>12:30</td>
<td>Tu2C4</td>
<td>High Resolution Ultra-Violet Radiation Detection Using TTN-Integrated Wireless Passive Microwave Resonator</td>
<td>M.C. Jain, Univ. of British Columbia; M. Alijani, Univ. of British Columbia; B.D. Wiltshire, Univ. of British Columbia; J.M. Macaik, Brno Univ. of Technology; M.H. Zarifi, Univ. of British Columbia</td>
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<tr>
<td>12:40</td>
<td>Tu2C5</td>
<td>A Machine Learning Enabled mmWave RFID for Rotational Sensing in Human Gesture Recognition and Motion Capture Applications</td>
<td>A. Ayedeye, Georgia Tech; C. Lynch, Georgia Tech; J. Hester, Athera Inc.; M.M. Tentzeris, Georgia Tech</td>
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<tr>
<td>12:50</td>
<td>Tu2C6</td>
<td>An E-Band Subradix Active Phase Shifter with &lt;0.6° RMS Phase Error and 16dB Attenuation in 28nm CMOS</td>
<td>K. Zhao, Zhejiang Univ.; L. Qiu, Zhejiang Univ.; J. Chen, Zhejiang Univ.; Q. Dong, Zhejiang Univ.; Z. Qian, Zhejiang Univ.; Y.-C. Kuan, NYCU; Q. J. Gu, Univ. of California, Davis; C. Song, Zhejiang Univ.; Z. Xu, Zhejiang Univ.</td>
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<tr>
<td>13:00</td>
<td>Tu2D1</td>
<td>A 27–57GHz Down-Conversion Mixer with Bulk Injection Technology</td>
<td>Q. Dong, Zhejiang Univ.; L. Qiu, Zhejiang Univ.; S. Wang, Zhejiang Univ.; H. Gao, Zhejiang Univ.; K. Zhao, Zhejiang Univ.; Z. Qian, Zhejiang Univ.; J. Chen, Zhejiang Univ.; Y.-C. Kuan, NYCU; Q. J. Gu, Univ. of California, Davis; C. Song, Zhejiang Univ.; Z. Xu, Zhejiang Univ.</td>
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<tr>
<td>13:10</td>
<td>Tu2D2</td>
<td>A DC–50GHz DPDT Switch with &gt;27dBm IP1dB in 45nm CMOS SOI</td>
<td>Y. Liu, Georgia Tech; J. Park, Georgia Tech; H. Wang, Georgia Tech</td>
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<tr>
<td>13:20</td>
<td>Tu2D3</td>
<td>Compact, High-Isolation mmWave Frequency Conversion and Control Circuits</td>
<td>J.S.-C. Chien, Univ. of California, Santa Barbara; J.F. Buckwalter, Univ. of California, Santa Barbara</td>
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<tr>
<td>13:30</td>
<td>Tu2D4</td>
<td>A 1–170GHz Distributed Down-Converter MMIC in a 35-nm Gate-Length InGaAs mHEMT Technology</td>
<td>Fabian Thome, Fraunhofer IAP; Sandrine Wagner, Fraunhofer IAP; Arnulf Leuthe, Fraunhofer IAP</td>
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</table>
Attention all Young Professionals (YP’s)!

Whether you’re still navigating your graduate studies, have just kick-started your career or have already taken your deep dive, we’ve got you covered! At IMS2022, you’ll find a variety of events designed to take you to the peak of your microwave career:

- Step out of your niche and broaden your knowledge on microwave applications with our Industry Panel Sessions, a unique chance to discuss with the experts from a variety of fields.
- Mingle with the MTT-S Publications Editors in Chief during our exclusive Editors in Chief Reception—limited attendance, grab your spot!
- Network with your peers in a relaxed setting at our Networking Reception for Young Professionals.
- Develop yourself with our Career and Technical Presentations.

And have some fun!

- Join the RF Interference Fox Hunt, where you will work as a team to find RF signals hidden throughout the area.
- Compete in our Cornhole Tournament.
- Visit our Young Professionals Lounge to charge up between sessions, relax and find out what more we have in store for you!

Sponsored By:

Microwaves&RF

Schedule of YP Events (subject to change)

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<th>Tuesday, 21 June</th>
<th>Wednesday, 22 June</th>
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<tr>
<td><strong>YP Lounge Open</strong></td>
<td><strong>Coronah Tournament</strong> **</td>
<td><strong>How Does a Spectrum Auction Work?</strong></td>
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<tr>
<td>09:00 – 11:00</td>
<td>09:00 – 16:00</td>
<td>10:00 – 11:30</td>
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<tr>
<td><strong>RF Interference Fox Hunt</strong></td>
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<td><strong>RF Interference Fox Hunt</strong></td>
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<td>14:00 – 15:00</td>
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<td>14:00 – 15:00</td>
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<tr>
<td><strong>What is a Patent?</strong></td>
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<td><strong>Impact of Globalization and Remote Working on Career Progression of Young Engineers</strong></td>
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<td>15:00 – 16:00</td>
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<td>15:00 – 16:00</td>
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<tr>
<td><strong>Panel Session: Your Next Professional Step</strong></td>
<td><strong>Wireless Technology: From Landline to xG</strong></td>
<td><strong>Interplanetary Communication: Communicating Off-Planet</strong></td>
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<td>16:00 – 17:00</td>
<td>15:00 – 16:00</td>
<td>15:00 – 16:00</td>
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<tr>
<td><strong>Panel Session: World of Radar</strong></td>
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<td><strong>YP Exclusive Reception with IEEE Editors-in-Chief (Spots Limited)</strong> **</td>
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<tr>
<td>17:30 – 18:30</td>
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<td>19:00 – 21:00</td>
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<tr>
<td><strong>YP Evening Reception at ViewHouse Eatery, Bar and Rooftop</strong></td>
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<td><strong>(Must be 21+)</strong> **</td>
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<td>SESSION CODE</td>
<td>TIME &amp; LOCATION</td>
<td>TITLE AND ABSTRACT</td>
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<tr>
<td>IWTU1</td>
<td>08:00 – 9:40</td>
<td>24-44 GHz Up-Down Converter Design Accelerator Ecosystem mmWave is the new frontier in RF design. There are many advantages of working at these frequencies and more opportunity as more bands are opened for different applications. There are also many difficulties, especially for those that do not have a lot of experience. Richardson RFPD has made available a 24-44 GHz up-down converter design accelerator to help alleviate some of those difficulties. It can be used to help demonstrate a concept to your customer, to start your algorithm development, or as a reference design. The workshops goal is to demonstrate and to show its applications.</td>
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<tr>
<td>IWTU2</td>
<td>10:10 – 11:50</td>
<td>New Workflows for Integrated 5G Phased-Array Antenna System Design Advances in front-end RFIC electronics and highly integrated RF PCB designs are making it possible to adopt phased-array systems for commercial mmWave applications. This workshop explores recent developments in mmWave technology from the perspective of EM simulation, in-situ circuit simulation, phased-array synthesis, and RF PCB design. The system requirements that drive antenna/front-end architectural decisions for mmWave applications, antenna optimization, and array configuration and generation will be discussed and the use of RF system design software for link budget analysis will be demonstrated.</td>
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<tr>
<td>IWTU3</td>
<td>13:30 – 15:10</td>
<td>Novel 5G Measurement Techniques in Diverse Environments 5G and emerging wireless technologies are being considered in a wide range of spectrum bands to support a significantly increased user density. With the industry’s adoption of multi-user MIMO, massive MIMO, and mmWave in emerging wireless systems, several worldwide industries and standards bodies face new measurement challenges in NR OTA testing to verify products meet intended performance parameters demanded by diverse technological requirements. Applications in diverse environments, such as commercial aircraft and base stations, will be reviewed. Experts and active contributors to the 5G wireless industry standards committees will review these challenges and propose novel solutions.</td>
</tr>
<tr>
<td>IWTU4</td>
<td>15:40 – 17:00</td>
<td>Accelerated Solid State Qubit Pre-Screening Until recently, quantum engineers operating devices at milli-Kelvin temperatures are faced with the difficulties and inconveniences of long development cycles. The major bottlenecks include time-consuming wire bonding, expensive packaging processes prior to device cooldown, and long cooldown times for dilution refrigerators. This workshop presents an integrated measurement solution for Pre-Screening qubit devices, allowing quantum engineers to eliminate wire-bonding and packaging from cryogenic test processes and to provide critical qubit performance parameters at 50 mK, thus streamlining device deployment, and reducing the time for development cycles.</td>
</tr>
<tr>
<td>IWTU5</td>
<td>13:30 – 15:10</td>
<td>Mixed-Mode/Differential S-Parameter Characterization At Cryogenic Temperatures For Quantum Computing Applications 2-port S-parameter characterization of wafer-level devices at cryogenic temperatures has a relatively long history; however, there has been considerably less work on differential/mixed-mode S-parameter characterization in these environments. With the emergence of cryogenic temperature microwave systems for quantum computing, there is increasing interest in high frequency integrated circuit design with differential signaling for cold environments. Here we will discuss the instrumentation, probes, calibrations, and environmental consideration for wafer-level characterization of differential devices at cryogenic temperatures and magnetic fields.</td>
</tr>
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</table>

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<thead>
<tr>
<th>SESSION CODE</th>
<th>TOPIC</th>
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<tr>
<td>SDC1</td>
<td>Design of a Self-Interference Cancellation Coupler</td>
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<tr>
<td>SDC2</td>
<td>Packaged C-band Filter</td>
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<tr>
<td>SDC3</td>
<td>VHF High-Efficiency Power Amplifier at 50MHz</td>
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<tr>
<td>SDC4</td>
<td>High-Efficiency Power Amplifier</td>
</tr>
<tr>
<td>SDC5</td>
<td>High-Sensitivity Motion Sensing Radar</td>
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<tr>
<td>SDC6</td>
<td>Measurement and Extraction of Device Parameters of an RF Transistor</td>
</tr>
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</table>
This is the Right Way to Architect the Microwave Control for Quantum Computers!

**ABSTRACT:** Precise control of the qubits is an essential, yet relatively immature, aspect in the development of quantum computers and is particularly difficult for cryogenic systems. This panel will debate the very different approaches being explored for microwave control signals of the qubits: CMOS vs. superconducting circuits; on the qubit plane vs. a higher temperature stage, etc. The panelists will describe their current approach and the path they intend to take as they scale to larger qubit circuits. The session will include participation from researchers at: Google, Intel, Seeqc, and Equal1.

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Race to the Next G – Ride the mmWave or Wave Goodbye!

**ABSTRACT:** A Millimeter-Wave (mmW) 5G promises high capacity and low latency by tapping into the wide bandwidth available in the Ka-band. Although there are practical limitations when using such band for non-line-of-sight communication as well as difficulty in realizing energy-efficient and cost-effective circuitry, mobile operators and technology companies have been making considerable investments in developing and deploying mmW equipment, while few continue to bid on the C-band and are willing to pay tens of billions for a 160MHz slice in it. Is now a good time to pause and reevaluate or is the global deployment of 5G mmW networks inevitable? What has the user experience with 5G networks been so far and what are the expectations for 6G and beyond? Do mmW mobile communications make engineering and economic sense and should we push for even higher bands (THz) in the next G? This panel of international experts from various industry sectors and academia will discuss the technical practicality and economics of 5G mmW deployment, and assess the potential for use of even higher frequency bands (D-band and above) in next generation communications.

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The Connected Future Summit will review core technologies for future wireless networks along with their human and societal impacts. Topics include smart cities, connected transportation, unmanned aerial vehicles, reconfigurable devices and beamsteering, and the need for a holistic approach to 6G. Special features include a panel session on overcoming bottlenecks in 6G and a fireside chat with experts on non-terrestrial networks.

**SPKERS:**

- Keynote: Dessa Bokides, NEOM
- Upkar Dhaliwal, Future Wireless Technologies
- Joyti Sharma, Verizon Wireless
- Peter Burke, University of California Irvine
- Francesco Grilli, Qualcomm Inc.
- Carmel Ortiz, Intelsat Corp.
- Lizy Paul, Lockheed Martin Corp.
- Reza Arefi, Intel Corp.
- Khurram Muhammad, Samsung Research America
- Shariar Shahramian, Nokia-Bell Labs
- Emilio Calvanese, CEA-France
- Jon Strange, MediaTek Inc.
- Omar Bakr, Tarana Wireless Inc.
- Mike Noonen, MixComm Inc.
- Dr. Naveen Yanduru, Renesas Electronics
- Holger Maune, University Magdeburg
- Charlie Zhang, Samsung Research America
- Aarno Pärssinen, University of Oulu
- Christian Fager, Chalmers University of Technology
- Raghu M. Rao, AMD Xilinx
- Timothy O’Shea, DeepSig

Sponsored By: RF Globalnet

To view the complete schedule please visit https://ims-ieee.org/connectedfuturesummit or reference the mobile app.
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<th>Chair/speaker(s)</th>
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<tr>
<td>13:30</td>
<td>Tu3A-1</td>
<td>Inset Resonators and Their Applications in Fixed/Reconfigurable Microwave Filters</td>
<td>D. Widaa, CAU; C. Bartlett, CAU; M. Hefner, CAU</td>
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<tr>
<td>13:30</td>
<td>Tu3A-2</td>
<td>Tunable Multi-Band Non-Reciprocal Bandpass Filters</td>
<td>D. Simpson, Univ. of Colorado Boulder; P. Vryonides, Frederick Research Center; S. Nikolaou, Frederick Research Center; D. Psychoglu, Univ. College Cork</td>
</tr>
<tr>
<td>13:30</td>
<td>Tu3A-4</td>
<td>Reconfigurable Multi-Mode Resonators and Filters</td>
<td>Chair: Roberto Gómez-García, Universidad de Alcalá; Co-Chair: Kun Gong, Univ. of Central Florida</td>
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<tr>
<td>13:30</td>
<td>Tu3A-5</td>
<td>Microwave Field, Device &amp; Circuit Techniques Professional Components</td>
<td>Chair: Prof. Dieff Vital, The Univ. of Illinois, Chicago; Co-Chair: Kenjiro Nishikawa, Kagoshima Univ.</td>
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<tr>
<td>13:30</td>
<td>Tu3B-1</td>
<td>Rectifier Circuit for 5G mm-Wave Energy Harvesting Using Capacitor Boosted Cross-Coupled Topology in 65nm CMOS</td>
<td>T. Elazar, Tel Aviv Univ.; E. Shaulov, Tel Aviv Univ.; E. Socher, Tel Aviv Univ.</td>
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<tr>
<td>13:30</td>
<td>Tu3B-2</td>
<td>A W-Band Rectifier Design Based on GCPW</td>
<td>N. Chordas-Ewell, SUNY Buffalo; Z. Li, SUNY Buffalo; J.H. Choi, SUNY Buffalo; D. Ren, NXP Semiconductors; R. Wu, NXP Semiconductors</td>
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<tr>
<td>13:30</td>
<td>Tu3B-3</td>
<td>Improving Wireless Power Transfer Efficiency with DC/DC Boost Charger by Multi-Sine Excitation at 5.6 GHz</td>
<td>Marco Passafiume, Univ. of Florence; Giovanni Collodi, Dept. Information Engineering, Univ. of Florence; Alessandro Cidonni, Dept. Information Engineering, Univ. of Florence</td>
</tr>
<tr>
<td>13:30</td>
<td>Tu3B-5</td>
<td>Analog VHF-IQ Receiver with Low IF</td>
<td>R. Campbell, Portland State Univ.; K. Dahn, Portland State Univ.</td>
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<tr>
<td>13:30</td>
<td>Tu3C-1</td>
<td>Rectenna and Signal Design for RF Power Transmission and Energy Harvesting</td>
<td>Chair: Sorin Voinigescu, Peter Schvan, STMicroelectronics; Pascal Chevalier, STMicroelectronics; Gregory Shai Bonen, Univ. of Toronto; High Precision Devices</td>
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<tr>
<td>13:30</td>
<td>Tu3C-2</td>
<td>A Cryogenic On-Chip Noise Characterization for Quantum Systems</td>
<td>Chair: Fabio Sebastian, Technische Universität Delft; Co-Chair: Evan Jeffrey, Google</td>
</tr>
<tr>
<td>13:30</td>
<td>Tu3C-3</td>
<td>Synthesis of Broadband Differential Loading Networks for High-Efficiency Power Amplifiers</td>
<td>R.A. Beltran, Ophir RF</td>
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<tr>
<td>13:30</td>
<td>Tu3C-4</td>
<td>A GaN HF-Band Power Amplifier Using Class-D Topology for Jupiter Ice Penetrating Radar</td>
<td>T. Shenoy, Jet Propulsion Lab; R. Johnson, Jet Propulsion Lab; J. Tanabe, Jet Propulsion Lab; R. Beauchamp, Jet Propulsion Lab; L. Yam, Jet Propulsion Lab; Y. Gim, Jet Propulsion Lab; D. Heyer, Jet Propulsion Lab; J. Plaut, Jet Propulsion Lab</td>
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<td>Tu3C-5</td>
<td>Design of an HF-VHF Ice Penetrating Synthetic Aperture Radar</td>
<td>J.D. Hawkins, P.V. Brennan, Univ. College London; K.W. Nicholls, British Antarctic Survey; L.B. Lok, Univ. College London</td>
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<td>Tu3E-1</td>
<td>Measurement Techniques for Superconducting Microwave Resonators Towards Quantum Device Applications</td>
<td>C.R.H. McRae, Univ. of Colorado Boulder</td>
</tr>
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RFIC TECHNICAL SESSIONS

13:30 – 15:10
Tuesday, 21 June 2022
Colorado Convention Center

1A-1C

RTu3A: Circuits and Techniques for Full Duplex Transceivers

Chair: Roxann Broughton-Blanchard, Analog Devices, USA
Co-Chair: Mohyee Mikhemar, Broadcom, USA

RTu3A-1: An Integrated Reconfigurable SAW-Less Quadrature Balanced N-Path Transceiver for Frequency-Division and Half Duplex Wireless

E. Zolkov, Technion; N. Ginzberg, Technion; E. Cohen, Technion

RTu3A-2: A 0.5–4GHz Full-Duplex Receiver with Multi-Domain Self-Interference Cancellation Using Capacitor Stacking Based Second-Order Delay Cells in RF Cancellor

C. Wang, Fudan Univ.; W. Li, Fudan Univ.; F. Chen, Fudan Univ.; W. Zuo, Fudan Univ.; Y. Pu, Fudan Univ.; H. Xu, Fudan Univ.

RTu3A-3: A 2Gb/s 9.9pJ/b Sub-10GHz Wireless Transceiver for Reconfigurable FDD Wireless Networks and Short-Range Multicast Applications


RTu3A-4: Fully Integrated Ultra-Wideband Differential Circulator Based on Sequentially Switched Delay Line in 28nm FinFET CMOS

J. Hwang, Yongsei Univ.; B.-W. Min, Yongsei Univ.

RTu3A-5: A C-Band Commutated-LC-Negative-R Delay Circuit with Harmonic Power Recycling Achieving 1.5ns Delay, 1.4GHz BW, and 6dB IL

S. Ming, Univ. of Illinois at Urbana-Champaign; R. Islam, Univ. of Illinois at Urbana-Champaign; J. Zhou, Univ. of Illinois at Urbana-Champaign

1D-1F

RTu3B: mm-Wave/THz Devices and BIST/ Calibration, and Circuits for Emerging Applications

Chair: Mona Hella, Rensselaer Polytechnic Institute, USA
Co-Chair: Fabio Sebastiano, Technische Universität Delft, The Netherlands

RTu3B-1: LNRFET Device with 325/475GHz fT/fMAX and 0.47dB NFMIN at 20GHz for SATCOM Applications in 45nm PDSOI CMOS

S.V. Khokale, GLOBALFOUNDRIES; T. Ethirajan, GLOBALFOUNDRIES; H.K. Kakara, GLOBALFOUNDRIES; B. Humphrey, GLOBALFOUNDRIES; K. Shanbhag, GLOBALFOUNDRIES; V. Yamakura, GLOBALFOUNDRIES; V. Jain, GLOBALFOUNDRIES; S. Jain, GLOBALFOUNDRIES

RTu3B-2: E-Band CMOS Built-In Self-Test Circuit Capable of Testing Active Antenna Impedance and Complex Channel Response

S.-U. Choi, POSTECH; K. Kim, POSTECH; K. Lee, POSTECH; S. Lee, POSTECH; H.-J. Song, POSTECH

RTu3B-3: Millimeter-Wave VNA Calibration Using a CMOS Transmission Line with Distributed Switches

J.-C. Chien, National Taiwan Univ.

RTu3B-4: Multi-Tone Frequency Generator for Gate-Based Readout of Spin Qubits

M. Ouvrier-Buffet, CEA-LETI; A. Sillogas, CEA-LETI; J.L. Gonzalez-Jimenez, CEA-LETI

RTu3B-5: A Dual-Antenna, 263GHz Energy Harvester in CMOS for Ultra-Miniaturized Platforms with 13.6% RF-to-DC Conversion Efficiency at 8dBm Input Power

M.I.W. Khan, MIT; E. Lee, MIT; N.M. Monroe, MIT; A.P. Chandrakasan, MIT; R. Han, MIT

10:00 – 10:30
Tuesday, 21 June 2022

HAM Radio Hidden Transmitter Hunt and Social

19:00 – 21:00
Tuesday, 21 June 2022

The Ham Radio Social at IMS2022 will include a Hidden Transmitter Hunt, organized and run by a female team of students/young professionals. We will start with a short presentation and demonstration of the equipment, divide up into small teams and attempt to locate two different types of hidden RF sources. All radio amateurs and other interested IMS participants are cordially invited to attend the event.
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<td>TUMA1</td>
<td>09:30 – 9:45</td>
<td>10 GHz Dielectric-Resonator-Based Surface Scanners for the Imaging of Microwave, 5G, and Energy Materials</td>
<td>Marzena Olszewska-Placha, Malgorzata Celuch, Janusz Rudnicki, QWED Sp. z o.o.</td>
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<tr>
<td>TUMA2</td>
<td>09:45 – 10:00</td>
<td>Designing Waveguide Microwave Filters Using Automatic 3D Modelling and AI Optimization</td>
<td>Diamond Liu, SynMatrix Technologies</td>
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<td>TUMA3</td>
<td>10:00 – 10:15</td>
<td>Dielectric Constant Measurement Up to 330 GHz, Super Repeatable with Simple Operation</td>
<td>Yoshiyuki Yanagimoto, EM Labs Inc.</td>
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<td>TUMA4</td>
<td>10:15 – 10:30</td>
<td>Embedding of Active ICs into Thin Film Circuits — Enabling High Density Hybrid Integration</td>
<td>Michele Stampanoni, Cicor Group</td>
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<td>TUMA5</td>
<td>10:30 – 10:45</td>
<td>Frequency Equalization Through Rapid and Customizable Design Approach</td>
<td>Mo Hasanovic, Smiths Interconnect Inc.</td>
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<td>TUMA6</td>
<td>10:45 – 11:00</td>
<td>From Design to Real RF Device — Connecting EDA Simulation and Hardware Test</td>
<td>Markus Loerner, Rohde &amp; Schwarz GmbH &amp; Co KG</td>
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<tr>
<td>TUMA7</td>
<td>11:00 – 11:15</td>
<td>Investigate RF Power Amplifier Linearization Benefits in EDA— Including a Comparison to Hardware Test</td>
<td>Markus Loerner, Rohde &amp; Schwarz GmbH &amp; Co KG</td>
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<td>TUMA9</td>
<td>11:30 – 11:45</td>
<td>Reducing Complexity in Calibration with a Measuring Receiver with Integrated Phase Noise Test</td>
<td>Wolfgang Wendler, Rohde &amp; Schwarz GmbH &amp; Co KG</td>
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<tr>
<td>TUMA10</td>
<td>11:45 – 12:00</td>
<td>The Effect of Semiconductor Laser Thermal Transfer in Relation to AuSn Preform Thickness</td>
<td>Jenny Gallery, Indium Corporation</td>
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<td>TUMA11</td>
<td>12:00 – 12:15</td>
<td>The Industry’s First, Low Loss, 3D Printable Photopolymer RF Material</td>
<td>John Coonrod, Rogers Corporation</td>
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<td>TUMA12</td>
<td>12:15 – 12:30</td>
<td>Virtuoso PDK Support in Microwave Office for Silicon MMIC Design and Heterogeneous Technology Integration</td>
<td>David Vye, Gus Dallman, Cadence</td>
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<td>TUMA14</td>
<td>12:45 – 13:00</td>
<td>Accelerated Periodic Structure Simulation Utilizing Reusable Sub-Structures</td>
<td>Ralf Ihmels, Mician GmbH</td>
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<td>TUMA15</td>
<td>13:00 – 13:15</td>
<td>Addressing Performance and Reliability Concerns with Thermal Analysis for RF Power Applications</td>
<td>David Vye, Cadence</td>
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<td>TUMA16</td>
<td>13:15 – 13:30</td>
<td>Addressing Thermal Challenges in High Speed and High-Power Microwave Devices</td>
<td>Dustin Kendig, Microsanj</td>
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<td>TUMA17</td>
<td>13:30 – 13:45</td>
<td>An Overview of Copper Foil, How It’s Made, Roughness Effects and RF—HSD Influences</td>
<td>John Coonrod, Rogers Corporation</td>
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<td>TUMA18</td>
<td>13:45 – 14:00</td>
<td>Best Practices for Mitigating the Shortcomings of Common Chip Scale Packaging Processes</td>
<td>Craig Blanchette, BAE Systems; Darby Davis, Gel-Pak</td>
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<td>TUMA19</td>
<td>14:00-14:15</td>
<td>D-Band FMcW Radar for VNA-like S-Parameter Measurements</td>
<td>Timo Jaeschke, Simon Kueppers, Jan Barowski, 2pi Labs GmbH; Lukas Piotrowsky, Ruhr Univ. Bochum</td>
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<tr>
<td>TUMA20</td>
<td>14:15-14:30</td>
<td>IEEE Low-Earth-Orbit (LEO) Satellites; Systems</td>
<td>Jan Budroweit, German Aerospace Center; Markus Gardill, Brandenburg Univ. of Technology; Witoltd Kinsner, Univ. of Manitoba; Mahjeda Ali, IEEE</td>
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<tr>
<td>TUMA21</td>
<td>14:30 – 14:45</td>
<td>Challenges of Automatic Fixture Removal (AFR) in Cryogenic Environments</td>
<td>David Daughton, Scott Yano, Lake Shore Cryotronics; Andy Owen, Keysight Technologies</td>
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<tr>
<td>TUMA22</td>
<td>14:45 – 15:00</td>
<td>Chambers and Positioners for 5G Emissions Testing</td>
<td>Jari Vikstedt, ETS-Lindgren</td>
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<td>TUMA23</td>
<td>15:00 – 15:15</td>
<td>De-embedding Test Fixtures for High Data-Rate VNA Signal Integrity Measurements</td>
<td>Rich Pieciak, Rohde &amp; Schwarz GmbH &amp; Co KG</td>
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<tr>
<td>TUMA24</td>
<td>15:15 – 15:30</td>
<td>De-embedding Test Fixtures for RF &amp; Microwave Components</td>
<td>Rich Pieciak, Rohde &amp; Schwarz GmbH &amp; Co KG</td>
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<tr>
<td>TUMA25</td>
<td>15:30 – 15:45</td>
<td>How to Get Consistent Millimeter-Wave Performance Using Grounded Coplanar Waveguide</td>
<td>John Coonrod, Rogers Corporation</td>
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<td>TUMA26</td>
<td>15:45 – 16:00</td>
<td>Impedance Matched Interconnects with Aerosol Jet for Millimeter-Wave RF Devices</td>
<td>Don Novotny, Optomec</td>
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<td>TUMA27</td>
<td>16:00 – 16:15</td>
<td>Improving Lossy Media Reflection Measurements with a Portable Network Analyzer</td>
<td>Subbaiah Pemmaiah, Copper Mountain Technologies</td>
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<td>TUMA28</td>
<td>16:15 – 16:30</td>
<td>Materials Characterization and Assessment for 5G-mmWave Applications</td>
<td>Malgorzata Celuch, QWED; Say Phommakesone, Keysight Technologies</td>
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<tr>
<td>TUMA29</td>
<td>16:30 – 16:45</td>
<td>Minimize the Impact that Test Fixturing Has on Your Test Results</td>
<td>Lawrence Wilson, Rohde &amp; Schwarz GmbH &amp; Co KG</td>
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<tr>
<td>TUMA30</td>
<td>16:45 – 17:00</td>
<td>New Power Measurement Techniques for Today’s Demanding RF World</td>
<td>Lawrence Wilson, Rohde &amp; Schwarz GmbH &amp; Co KG</td>
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A Wideband Two-Way Digital Doherty Transmitter in 40nm CMOS | Th03C_2
Student Finalist: Mohammadreza Beikmirza, Delft Univ. of Technology
Advisor: Morteza S. Alavi, Delft Univ. of Technology

Miniaturized 28 Gzh Package Bandpass Filter with High Selectivity and Wide Stopband Using Multi-Layer Pcb Technology | We02A_6
Student Finalist: Yunbo Rao, Univ. of Electronic Science and Technology of China
Advisor: Xun Luo, Univ. of Electronic Science and Technology of China

Design and Implementation of a 3.9-to-5.3 GHz 65 nm Cryo-CMOS LNA with an Average Noise Temperature of 10.2 K | We04D_2
Student Finalist: Sayan Das, Univ. of Massachusetts, Amherst
Advisor: Joseph Bardin, Univ. of Massachusetts Amherst

33 GHz Overmoded Bulk Acoustic Resonator | Th02B_1
Student Finalist: Zachary Schaffer, Carnegie Mellon Univ.
Advisor: Gianluca Piazza, Carnegie Mellon Univ.

Deep Learning Enabled Inverse Design of 30-94 GHz Psat, 3dB SiGe PA Supporting Concurrent Multi-band Operation at Multi-Gbps | We02C_1
Student Finalist: Zheng Liu, Princeton Univ.
Advisor: Kaushik Sengupta, Princeton Univ.

Josephson Junctions Based Low Temperature Superconducting Phase Shifter for X- and K-band using MIT-LL SFQsee Process | Tu02E_1
Student Finalist: Raafat R. Mansour, Univ. of Waterloo
Advisor: Raafat R. Mansour, Univ. of Waterloo

Load-Modulation-Based IMD3 Cancellation for Millimeter-Wave Class-B CMOS Power Amplifiers Achieving EVM<1.2% | We02E_1
Student Finalist: Masoud Pashaefar, Delft Univ. of Technology
Advisor: Morteza S. Alavi, Delft Univ. of Technology

Fused-Silica Stitch-Chips with Compressible Microinterconnects for Embedded RF/mm-Wave Chiplets | We03B_3
Student Finalist: Ting Zheng, Georgia Institute of Technology
Advisor: Muhammed S. Bakir, Georgia Institute of Technology

860 µW Terahertz Power Generation from Graded Composition InGaAs Photocative Nanoantennas | Th01C_2
Student Finalist: Ping-Keng Lu, Univ. of California, Los Angeles
Advisor: Mona Jarrahi, Univ. of California, Los Angeles

A 190-to-220GHz 4-bit Passive Attenuator with 1.4dB Insertion Loss and Sub-0.34dB RMS Amplitude Error using Magnetically Switchable Coupled-Lines in 0.13-µm CMOS Technology | We04G_4
Student Finalist: Nengxu Zhu, Tianjin Univ.
Advisor: Fanyi Meng, Tianjin Univ.

**IMS STUDENT PAPER COMPETITION & QUANTUM DAY RECEPTION**

**THIS YEAR’S IMS STUDENT PAPER COMPETITION FINALISTS:**

Tuesday, 21 June 2022 Room: 2A–3B

**Interactive Forum Session**

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**Chairs:** Justus Brevik, Robert Horansky, Akim Babenko, NIST
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<td>E. Wagner, Northrop Grumman; T. Larocca, Northrop Grumman; M. Verderber, Nuvotronics; C. Rezende, Nuvotronics; P. May, Nuvotronics</td>
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<td>E. Wagner, Northrop Grumman; T. Larocca, Northrop Grumman; M. Verderber, Nuvotronics; C. Rezende, Nuvotronics; P. May, Nuvotronics</td>
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**1A - 1C**

**We1E: High Power GaN RF and Microwave Power Amplifiers**

**Chair:** Nestor Lopez, MIT Lincoln Laboratory  
**Co-Chair:** Michael Roberg, Qorvo

**We1E-1: A 700–2800MHz Switchless Class-G Power Amplifier with Two-Quadrant Modulation for Back-Off Efficiency Improvement**

X. Chen, Tsinghua Univ.; M. Zhao, Tsinghua Univ.; W. Chen, Tsinghua Univ.; Z. Feng, Tsinghua Univ.

**We1F: Radar from Space to Ground (and Below) — The Synergy Between Commercial, Government, and Metrology Applications**

**Chair:** Nils Pohl, Ruhr Univ. Bochum

**We1F-1: Keynote: Recent Radar Advances and Their Impact**

Joseph Guerci, Information Systems Labs, Inc.

**We1F-2: Upgrading the HUSIR Radar for Deep-Space Satellite Imaging**

M.D. Abuzahtra, MIT Lincoln Laboratory; M.E. MacDonald, MIT Lincoln Laboratory; R.K. Lee, MIT Lincoln Laboratory; D.L. Grimes, MIT Lincoln Laboratory; B.H. Simakauskas, MIT Lincoln Laboratory; N. Lopez, MIT Lincoln Laboratory; C. Eckert, MIT; I.M. Usoff, MIT Lincoln Laboratory

**We1F-3: Influence of Soil Moisture on the Detection of Buried Objects Using an Airborne GPSAR**

A. Grathwohl, Universität Ulm; B. Andri, Technische Hochschule Ulm; T. Walter, Technische Hochschule Ulm; C. Waldschmidt, Universität Ulm

**We1F-4: Frequency-Domain Characterization of Millimeter-Wave FMWC Signal Based on a Precisely Synchronized VNWA Measurement Setup**

Y. Zhang, NIM; D. Wu, CATARC; H. Gao, NIM; Z. He, NIM; M. Nie, NIM

**We1G: mm-Wave and Terahertz Power Amplifiers and Front-End Modules**

**Chair:** Taiyun Chi, Rice Univ.  
**Co-Chair:** Joe Qiu, U.S. Army Research Office

**We1G-1: A Compact SiGe Stacked Common-Base Dual-band PA with 20/18.8dBm Psat at 36/64 GHz Supporting Concurrent Modulation**


**We1G-2: A 150–175GHz 30dB S21 G-Band Power Amplifier with 0.25W Poit and 15.7% PAE in a 250nm InP HBT Technology**

Z. Griffith, Teledyne Scientific & Imaging; M. Urteaga, Teledyne Scientific & Imaging; P. Rowell, Teledyne Scientific & Imaging; L. Tran, Teledyne Scientific & Imaging

**We1G-3: A 2-Stage, 140GHz Class-B Power Amplifier Achieving 22.5% PAE at 17.3dBm in a 250nm InP HBT Technology**

E. Lam, Univ. of California, Santa Barbara; K. Ning, Univ. of California, Santa Barbara; A. Ahmed, Univ. of California, Santa Barbara; M. Rodwell, Univ. of California, Santa Barbara; J.F. Buckwalter, Univ. of California, Santa Barbara

**We1G-4: Compact, 114GHz, High-Efficiency Power Amplifier in a 250nm InP HBT Process**

J.S.-C. Chien, Univ. of California, Santa Barbara; J.F. Buckwalter, Univ. of California, Santa Barbara

**We1G-5: GaN-on-Si Ka-Band Single-Chip Front-End MMIC for Earth Observation Payloads**

P.E. Longhi, Università di Roma “Tor Vergata”; F. Costanzo, Università di Roma “Tor Vergata”; L. Pace, Università di Roma “Tor Vergata”; W. Cicognavi, Università di Roma “Tor Vergata”; S. Colangeli, Università di Roma “Tor Vergata”; R. Giofrè, Università di Roma “Tor Vergata”; R. Leblanc, OMNIC; F. Vitobello, REA; E. Limiti, Università di Roma “Tor Vergata”

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**We1E-2: Investigation of Input Nonlinearity in Sequential Load Modulated Balanced Amplifiers**

C. Chu, Univ. College Dublin; T. Sharma, Renesas Electronics; S.K. Dhar, Renesas Electronics; R. Darraji, Ericsson; A. Zhu, Univ. College Dublin

**We1F-1: A 700–2800MHz Switchless Class-G Power Amplifier with Two-Quadrant Modulation for Back-Off Efficiency Improvement**

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**We1E-3: Intrinsically Mode-Reconfigurable Load-Modulation Power Amplifier Leveraging Transistor’s Analog-Digital Duality**

N.B. Yangpurasap, Univ. of Central Florida; H. Lyu, Univ. of Central Florida; Y. Cao, Univ. of Central Florida; K. Chen, Univ. of Central Florida

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Joseph Guerci, Information Systems Labs, Inc.

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**4D-4F**

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We2A-1: Design of In-Line Filter With Cross-Couplings Paths and Source Loaded Dangling Resonator Produced Transmission Zeros
Y. Wu, Tianjin Univ.; K. Ma, Tianjin Univ.; Y. Wang, Tianjin Univ.

We2A-2: Dual-Band SIW Filter with Widely Separated Passbands Based on TE101 and TE301 Modes
Y. Zhu, UESTC; Y. Dong, UESTC; X. Luo, UESTC; J. Bornemann, Univ. of Victoria

We2A-3: Miniaturized Tri-Band Bandpass Filter with Wide Stopband Using Stacked-Coupled SIW Cavities
Y. Zhou, UESTC; D. Tang, UESTC; Y. Rao, UESTC; Y. Dong, UESTC; X. Luo, UESTC

We2A-4: A Compact K-/Ka-Band Diplexer with Dual-Mode Folded SIW Cavities
N. Siew, Technische Universität Hamburg; A. Siegjanschin, Technische Universität Hamburg; K. Erkelenz, Technische Universität Hamburg; A.F. Jacob, Technische Universität Hamburg

We2A-5: Miniaturized Quarter-Mode SIW Filters Loaded by Dual-Mode Microstrip Resonator with High Selectivity and Flexible Response
Lin Gu, Yuanquan Dong, Xun Luo, Univ. of Electronic Science and Technology of China

We2A-6: Miniaturized 28 GHz Packaged Bandpass Filter with High Selectivity and Wide Stopband Using Multi-Layer PCB Technology
Yunbo Rao, Univ. of Electronic Science and Technology of China; Huizhen Qian, Univ. of Electronic Science and Technology of China; Jie Zhou, Univ. of Electronic Science and Technology of China; Yuanquan Dong, Univ. of Electronic Science and Technology of China; Xun Luo, Univ. of Electronic Science and Technology of China

We2B-1: Limitations and Importance of EM Models for On-Wafer High Frequency Performance Evaluation
N. Mahjabeen, Univ. of Texas at Dallas; Y. Zhang, Univ. of Minnesota; A. Dave, Univ. of Minnesota; J. Um, Univ. of Minnesota; A. Harpel, Univ. of Minnesota; B. Stadler, Univ. of Minnesota; R.R. Franklin, Univ. of Minnesota; R. Henderson, Univ. of Texas at Dallas

We2B-2: Generation of High-Order Modes in Sub-Terahertz Dielectric Waveguides by Misalignment of the Transition Structure
S. Srinivas, KTH; N. Xenidis, KTH; J. Oberhammer, KTH; D.V. Lioubtchenko, KTH

We2B-3: A Mode-Matching-Based Technique for Electromagnetic Characterization of Anisotropic Materials in Cylindrical Waveguides
R.R. Rodrigues, PUC-Rio; V.B. Cosenza, PUC-Rio; G.S. Rosa, PUC-Rio; R.A. Penchel, Universidade de São Paulo

We2B-4: Modeling Thick Metal in Forward Volume Spin Wave Transducers
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We2B-5: Design of In-Line Filter With Cross-Couplings Paths and Source Loaded Dangling Resonator Produced Transmission Zeros
Y. Wu, Tianjin Univ.; K. Ma, Tianjin Univ.; Y. Wang, Tianjin Univ.

We2B-6: Miniaturized Tri-Band Bandpass Filter with Wide Stopband Using Stacked-Coupled SIW Cavities
Y. Zhou, UESTC; D. Tang, UESTC; Y. Rao, UESTC; Y. Dong, UESTC; X. Luo, UESTC

We2B-7: Closed-Loop Antenna Impedance Tuning via Transfer Function Learning for 5G sub-6GHz User Equipment

We2B-8: An On-Chip Accelerator with Hybrid Machine Learning for Modulation Classification of Radio Frequency Signals
K. Jung, Georgia Tech; J. Woo, Georgia Tech; S. Mukhopadhyay, Georgia Tech

We2B-9: RF Fingerprinting of LoRa Transmitters Using Machine Learning with Self-Organizing Maps for Cyber Intrusion Detection
M. Nair, Univ. of Bristol; T. Cappello, Univ. of Bristol; S. Dang, Univ. of Bristol; V. Kalokidou, Univ. of Bristol; M.A. Beach, Univ. of Bristol

We2C-1: Deep Learning Enabled Inverse Impedance Tuning via Transfer Function Learning for 5G sub-6GHz User Equipment

We2C-2: AI/ML for RF and mm-Wave Applications
Chair: Rui Ma, MERL
Co-Chair: Abijith Chatterjee, Georgia Tech

We2C-3: An On-Chip Accelerator with Hybrid Machine Learning for Modulation Classification of Radio Frequency Signals
K. Jung, Georgia Tech; J. Woo, Georgia Tech; S. Mukhopadhyay, Georgia Tech

We2C-4: Design and Optimization of T-Coil Enhanced ESD Circuit with Upsampling Convolutional Neural Network
Z. Li, Univ. of Tokyo; A. Chan Carusone, Univ. of Toronto

We2C-5: A Novel Convolutional-Autoencoder Based Surrogate Model for Fast S-Parameter Calculation of Planar BPFs
R. Shibata, Saitama Univ.; M. Ohira, Saitama Univ.; Z. Ma, Saitama Univ.

We2C-6: Zeroth-Order Optimization for Varactor-Tuned Matching Network
M. Pirrone, Univ. of Colorado Boulder; E. Dall’Anese, Univ. of Colorado Boulder; T. Barton, Univ. of Colorado Boulder

We2C-7: Load-Modulation-Based IMD3 Cancellation for Millimeter-Wave Class-B CMOS Power Amplifiers Achieving EVM<1.2%
Masoud Pashaeifar, Delft Univ. of Technology; Leo de Vreede, Delft Univ. of Technology; Morteza Alavi, Delft Univ. of Technology

We2C-8: Mixture of Experts Neural Network for Modeling of Power Amplifiers
A. Fischer-Bühner, Nokia Bell Labs; A. Bihuega, Nokia; L. Antilla, Tampere Univ.; M.D. Gomony, Nokia Bell Labs; M. Vakka, Tampere Univ.

We2C-9: Hardware-Efficient Implementation of Piece-Wise Digital Predistorters for Wideband 5G Transmitters
M. Almoneer, Univ. of Waterlow; H. Barkhordar-pour, Univ. of Waterloo; P. Mitran, Univ. of Waterloo; S. Boumaiza, Univ. of Waterloo

We2C-10: An Intermodulation Distortion Oriented 256-Element Phased-Array Calibration for 5G Base Station
Y. Aoki, Samsung; Y. Kim, Samsung; Y. Hong, Samsung; H. Kang, Samsung; S. Kim, Samsung; A. S. Ryu, Samsung; S. G. Yang, Samsung
**WOMEN IN MICROWAVES (WIM)**

**Wednesday, 22 June 2022**

**18:00 – 21:00**

Chambers Grant Salon, Opera House, Denver Performing Arts Complex

Join us for a fun evening at IMS hosted by Women in Microwaves (WIM)!! This event welcomes all members of IMS to promote collaboration, with a spotlight on the work of female RF engineers and researchers.

We hope to see all IMS2022 attendees there (WIM, MIM and others)!

The evening starts with a technical poster session over snacks and open wine/beer bar. Join all attendees in a fun and creative group Smith chart painting contest, to be turned into a MTT tee-shirt or poster. Get to know your fellow WIM members in a friendly bingo game designed to help you network with some of our brightest up-and-coming female RF engineers and researchers.

Sponsored By:

**Microwaves&RF**
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<tr>
<th>SESSION CODE</th>
<th>TIME &amp; LOCATION</th>
<th>TITLE AND ABSTRACT</th>
<th>SPEAKER/S, AFFILIATION</th>
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<tr>
<td>IWWE1</td>
<td>08:00 – 9:40</td>
<td><strong>Broadband Over Temperature Measurement Optimization For On Wafer Test</strong>&lt;br&gt; We will highlight the best methods for setting up, calibrating, and evaluating measurement performance in coaxial and waveguide bands spanning WR15 (75 GHz) to WR1 (1100 GHz) over a broad (-40 to 125°C) temperature range. A novel out single sweep measurement from 900 Hz to 220 GHz will be shown along with detailed complete automation of these measurements. Hany programming examples using WinCalXE software will be demonstrated automating data measurement and analysis for on wafer measurements. We also evaluate system stability and performance. A very convenient approach is discussed to allow safe and convenience band swaps and probe installation.</td>
<td>Gavin Fisher, FormFactor</td>
</tr>
<tr>
<td>IWWE2</td>
<td>10:10 – 11:50</td>
<td><strong>From Design to Manufacturing; mmWave IC and Heterogeneous RF Integration in One Design Flow</strong>&lt;br&gt;The need to design and produce smaller, less expensive, and increasingly complex devices is the mantra of our industry. This has led to designs in smaller, more complex packages, smaller process nodes, and the use of multiple IC technologies, all within a shorter design cycle. This workshop will consider recent developments in EDA software that address the challenges of adopting advanced node silicon and heterogenous packaging technology for RF to mmWave applications.</td>
<td>Michael Thompson, Ron Pongratz Cadence</td>
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<tr>
<td>IWWE3</td>
<td>13:30 – 15:10</td>
<td><strong>Latest RF Frontend Topologies Including Olmba Measurement-Aided Design</strong>&lt;br&gt;5G is here. The focus is on improving systems and enhancing capabilities. This drives the integration of components, extending bandwidth coverage per RF channel and improving energy efficiency. We will look at enhanced filter and amplifier design and testing. Load Modulated Balanced Amplifier (LMBA) structures offer typically Doherty levels of efficiency with increased bandwidth. The workshop will provide an overview of the latest technologies and requirements of RF frontends. Experts from test and measurement and industry partners will provide solutions that meet demanding requirements and help to develop latest LMBA topologies using a measurement-aided approach.</td>
<td>Diamond Liu, SynMatrix Technologies; Gareth Lloyd, Rohde &amp; Schwarz; Salvatore Finocchiaro, QORVO, Inc.</td>
</tr>
<tr>
<td>IWWE4</td>
<td>15:40 – 17:00</td>
<td><strong>0.03-6 GHz Up/Down Converter + FPGA (BytePipe) Toolbox for Matlab and Simulink</strong>&lt;br&gt;We will demonstrate and discuss the BytePipe Toolbox for Matlab and Simulink which provides a set of tools for interfacing, modeling, and targeting designs using the BytePipe RF System on Module. The device interfaces will provide control and data streaming using MATLAB System Objects and Simulink Blocks. The control interface allows for configuration of components included in the Software Development Kit. This includes support for configuration of the ADI ADRV9002 Agile Transceiver and Xilinx ZynqMP Baseband Processor functions. Individual settings can be configured independently or as a whole. Design support includes filter/profile wizards, and tools commonly used in modern design.</td>
<td>Larry Hawkins, Richardson RFPD</td>
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**Have You Had Your Shoes Shined Yet?**

Get your shoes freshly shined outside the Exhibition Hall A entrance! Shoeshines are a time-honored tradeshow tradition. Stop by and relax your feet. You will walk away looking and feeling great!

Sponsored By:
**PANEL SESSION**

**The Trend of Tiny AI: Will Ultra-Low-Power Fully-Integrated Cognitive Radios Become a Reality?**

**PANEL ORGANIZERS:**
Jasmin Grosinger, Graz Univ. of Technology; Oren Eliezer, Apogee Semiconductor; Ke Wu, Polytechnique Montreal; J.-C. Chiao, Southern Methodist Univ.

**PANELISTS:**
Alyssa B. Apsel, Cornell Univ.; Nuno Borges Carvalho, Univ. of Aveiro; Scott Hanson, Ambiq; Gernot Hueber, Silicon Austria Labs; Tim Kwang-Ting Cheng, Hong Kong Univ. of Science and Technology

**ABSTRACT:** The trend of tiny AI eventually paves the way towards realizing fully-integrated cognitive radios on energy-constrained devices, making Mitola’s vision a reality. Currently, tiny AI-based devices operate at mW power consumption. Will uW power consumption become a reality? Will eventually cognitive radios exploiting tiny AI become a reality? In this panel, experts from multiple disciplines and IEEE societies will debate these questions and visions.

**PANEL SESSION**

**Small Satellites and Constellations: Who Will Be the Winners of the New Race to Space?**

**PANEL ORGANIZERS:**
Markus Gardill, Brandenburg Univ. of Technology; Steven Reising, Colorado State Univ.; Jan Budroweit, German Aerospace Center (DLR)

**PANELISTS:**
Klaus Schilling, Zentrum fuer Telematik (Center for Telematics); Jorge Ciccorossi, International Telecommunication Union (ITU); William Blackwell, MIT Lincoln Laboratory; Sachidananda Babu, NASA Earth Science Technology Office; Andreas Knopp, Universität der Bundeswehr München

**ABSTRACT:** There is a true spirit of optimism in the current development of small satellites for low-earth-orbit. Entirely new opportunities have been created for education, science, and industry. Well-known examples range from the plethora of CubeSat projects to several announced or deployed mega-constellations. Nevertheless, how will the anticipated intensive use of LEO affect the environment and the frequency spectrum usage, and how can a sustainable and fair-share use of resources be ensured? Let’s talk about this in our panel of leading experts from Small Businesses & Startups, Science and Education, Space Agencies, Communication, Regulation, and Space Debris.

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**Professional Headshots on the IMS Show Floor!**

Join us in Booth 2000 to get a complimentary headshot photo.

**Hours:** Tuesday, Wednesday, and Thursday **11:50-13:00**

During the Industry Hosted Reception on Wednesday **17:00-18:00**

**Sponsored By:**

![Wolfspeed Logo]
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<td>We3A-2</td>
<td>Millimeter-Wave High Q-Factor Sixteenth Mode SIW Cavity Resonator Implemented in 0.18μm CMOS Technology</td>
<td>S.K. Thapa, Kyushu Univ.; R.K. Pokharel, Kyushu Univ.; B. Chen, Kyushu Univ.; T. Fukuda, Kyushu Univ.; A. Barakat, Kyushu Univ.</td>
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<td>We3A-3</td>
<td>A 16:1 Bandwidth Planar Balun with Low Common Mode Impedance</td>
<td>D. Gustafsson, Ericsson; P. Ingelhag, Ericsson; K. Andersson, Ericsson; T. Dahl, Ericsson; R. Lindman, Ericsson; R. Lundqvist, Ericsson</td>
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<td>We3A-4</td>
<td>Rectangular Waveguide Radial Combiners Based on Curvilinear Matching Sections</td>
<td>M.M. Fahmi, DRDC; R.R. Mansour, Univ. of Waterloo</td>
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<td>We3A-5</td>
<td>Novel Waveguide Connectors to Simplify Microwave and Millimeter-Wave Component Packaging</td>
<td>Y. Shu, Eravant; L. Ren, Eravant</td>
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<td>We3B-1</td>
<td>Detachable Terahertz Chip-to-Chip Interconnectors</td>
<td>H.-Y. Tsao, Univ. of Virginia; Y. Wang, Univ. of Virginia; R.M. Weikle, Univ. of Virginia; A.W. Lichtenberger, Univ. of Virginia; N.S. Barker, Univ. of Virginia</td>
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<td>We3B-2</td>
<td>Fan-Out Wafer Level Packaging of GaN Traveling Wafer Amplifier</td>
<td>D. Schwantuschke, Fraunhofer IAF; E. Ture, Fraunhofer IAF; T. Braun, Fraunhofer IZM; T.D. Nguyen, Fraunhofer IZM; M. Wöhrmann, Fraunhofer IZM; M. Pretl, Rohde &amp; Schwarz; S. Engels, Rohde &amp; Schwarz</td>
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<tr>
<td>We3B-3</td>
<td>Fused-Silica Stitch-Chips with Compressible Microinterconnects for Embedded RF/mm-Wave Chiplets</td>
<td>T. Zheng, Georgia Tech; M.S. Bakir, Georgia Tech</td>
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<td>We3B-4</td>
<td>High-Integration and Low-cost Transmitter Packaging Solution for 0.2 Tbps SIP Application Using HTCC Technology</td>
<td>Bo Yu, Zhigang Wang, Univ. of Electronic Science and Technology of China; Peng Wu, Chinese Academy of Sciences; Ouqeng Li, Hua Cai, Jia He, Guangjian Wang, Huawei Technologies Co., Ltd.; Ruimin Xu, Univ. of Electronic Science and Technology of China</td>
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<td>We3B-5</td>
<td>110GHz Nanowire-Based Integrated Via Technology for 3D Silicon Integration</td>
<td>Y. Zhang, Univ. of Minnesota; J. Um, Univ. of Minnesota; N. Mahjabeen, Univ. of Texas at Dallas; B. Stadler, Univ. of Minnesota; R. Henderson, Univ. of Texas at Dallas; R.R. Franklin, Univ. of Minnesota</td>
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<tr>
<td>We3C-1</td>
<td>A Quantitative Analysis of Physical Security and Path Loss with Frequency for IBBO Channel</td>
<td>Arunashish Datta, Purdue Univ.; Mahesh Nath, Purdue Univ.; Baibhab Chatterjee, Purdue Univ.; Shovan Maity, Quaistics; Shreyas Sen, Purdue Univ.</td>
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<td>We3C-2</td>
<td>Detection of Rogue Devices Using Unintended Near and Far-Field Emanations with Spectral and Temporal Signatures</td>
<td>Md.F. Bari, Purdue Univ.; M. Roy Chowdhury, Purdue Univ.; B. Chatterjee, Purdue Univ.; S. Sen, Purdue Univ.</td>
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<td>We3C-3</td>
<td>Electromagnetic Analysis of Integrated On-Chip Sensing Loop for Side-Channel and Fault-Injection Attack Detection</td>
<td>Archisman Ghosh, Purdue Univ.; Mayukh Nath, Purdue Univ.; Debayan Das, Purdue Univ.; Santosh Ghosh, Intel Corp.; S. Sen, Purdue Univ.</td>
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<tr>
<td>We3C-5</td>
<td>RF-PSF: Zero-Trust Radio Frequency Process Specific Functions as Process Distinction Method</td>
<td>Md.F. Bari, Purdue Univ.; B. Chatterjee, Purdue Univ.; L. Duncan, KBR; S. Sen, Purdue Univ.</td>
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<tr>
<td>We3D-1</td>
<td>A W/F-Band Low-Noise Power Amplifier GaN MMIC with 3.5–5.5-dB Noise Figure and 22.8–24.3-dBm Pout</td>
<td>F. Thorne, Fraunhofer IAF; P. Brücknet, Fraunhofer IAF; S. Leone, Fraunhofer IAF; R. Quay, Fraunhofer IAF</td>
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<td>We3D-2</td>
<td>A Flip-Chip 180GHz Receiver in 40nm CMOS</td>
<td>H.-S. Chen, National Tsing Hua Univ.; Y.-L. Hu, National Tsing Hua Univ.; W.-C. Chang, National Tsing Hua Univ.; J.Y.-C. Liu, National Tsing Hua Univ.</td>
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<td>We3D-3</td>
<td>A Fully-Differential 146.6–157.4GHz LNA Utilizing Back Gate Control to Adjust Gain in 22nm FDSoI</td>
<td>P.J. Artz, Technische Universität Berlin; P. Scholz, Technische Universität Berlin; T. Maußolff, IHP; F. Gerfers, Technische Universität Berlin</td>
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<td>We3D-4</td>
<td>Experimental Characterization of Temperature-Dependent Microwave Noise of Discrete HEMTs: Drain Noise and Real-Space Transfer</td>
<td>B. Garbrichde, Caltech; K. Cleary, Caltech; J. Koel, Jet Propulsion Lab; I. Esho, Caltech; A.C. Readhead, Caltech; A.J. Minnich, Caltech</td>
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Don’t Miss the Industry Hosted Reception on Wednesday, 22 June from 17:00–18:00 on the IMS Show Floor!
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<tr>
<td>15:40</td>
<td>401-402</td>
<td>We4A: Advances in mm-Wave Passive Components &amp; Systems</td>
<td>Chair: Hoiger Maune, OvG Universität Magdeburg Co-Chair: Shrivas Prasad Mysores Nagaraja, Jet Propulsion Laboratory</td>
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<td>15:50</td>
<td>403-404</td>
<td>We4B: Advanced Manufacturing and Novel Substrates</td>
<td>Chair: Premjeet Chahal, Michigan State Univ. Co-Chair: Valentina Palazzi, Università di Perugia</td>
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<td>16:00</td>
<td>501-502</td>
<td>We4C: Advanced System Architectures and Concepts</td>
<td>Chair: Kavita Gouverdhanam, U.S. Army CCDC C5ISR Center Co-Chair: Ruochen Lu, Univ. of Texas at Austin</td>
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<td>16:10</td>
<td>503-504</td>
<td>We4D: Advances in Low-Power CMOS Low Noise Amplifiers (LNAs)</td>
<td>Chair: Shirin Montazeri, Google Co-Chair: Edward Nienhenke, Nienhenke Consulting</td>
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<td>16:30</td>
<td>403-404</td>
<td>We4B-1: Integrated and Miniaturized Quasi-Yagi D-Band Antenna in Glass Interposer</td>
<td>S. Erdogan, Georgia Tech; K.-S.J. Moon, Georgia Tech; M. Kathapenumal, Georgia Tech; M. Swaminathan, Georgia Tech</td>
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<td>16:40</td>
<td>501-502</td>
<td>We4C-1: 2-8 GHz Interference Detector with 1.1 μs Response</td>
<td>Mohammad Abu Khater, Purdue Univ.; Dimitrios Peroulis, Purdue Univ.</td>
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<td>16:50</td>
<td>503-504</td>
<td>We4D-1: A 3.2mW 2.2-13.2GHz CMOS Differential Common-Gate LNA for Ultra-Wideband Receivers</td>
<td>I. Zhang, Univ. of California, Davis; N.L.K. Nguyen, Univ. of California, Davis; J. Chen, Univ. of California, Davis; O. Momeni, Univ. of California, Davis; X. Liu, SUSTech</td>
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<td>17:00</td>
<td>401-402</td>
<td>We4A-2: A Ka-Band Wideband Monolithically Metallic 3-D Printed Turnstile Junction Orthomode Transducer with Shaped Internal Profile</td>
<td>S. Chen, Shenzhen Univ.; J. Li, Shenzhen Univ.; Z. Xu, Shenzhen Univ.; T. Yuan, Shenzhen Univ.</td>
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<td>17:10</td>
<td>403-404</td>
<td>We4B-2: Flexible and Scalable Additively Manufactured Tile-Based Phased Arrays for Satellite Communication and 5G mmWave Applications</td>
<td>K. Hu, Georgia Tech; G. Soto-Valle, Georgia Tech; Y. Cui, Georgia Tech; M.M. Tentzeris, Georgia Tech</td>
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<td>17:20</td>
<td>501-502</td>
<td>We4C-2: A 140–500GHz CMOS THz Spectroscope with 1MHz Resolution Based on Multi-Branch Rotational Symmetric Sensing Surface</td>
<td>C. Pi, UESTC; H.J. Qian, UESTC; T. Wang, UESTC; J. Zhou, UESTC; Z. Deng, UESTC; Y. Shu, UESTC; X. Luo, UESTC</td>
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<td>17:30</td>
<td>503-504</td>
<td>We4D-2: Design and Implementation of a 3.9-to-5.3GHz 65nm Cryo-CMOS LNA with an Average Noise Temperature of 10.2K</td>
<td>S. Das, UMass Amherst; S. Raman, UMass Amherst; J.C. Bardin, Google, UMass Amherst</td>
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<td>17:40</td>
<td>401-402</td>
<td>We4A-3: A Dual-Band Feed Network for Highly Integrated K-/Ka-Band Phased Array Front-Ends</td>
<td>K. Erkelenz, Technische Universität Hamburg; N. Sieleck, Technische Universität Hamburg; A.F. Jacob, Technische Universität Hamburg</td>
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<td>17:50</td>
<td>403-404</td>
<td>We4B-3: Additively Manufactured Slotted Waveguides for THz Applications</td>
<td>A. Hofmann, FAU Erlangen-Nürnberg; K. Lomakin, FAU Erlangen-Nürnberg; M. Sippel, FAU Erlangen-Nürnberg; G. Gold, FAU Erlangen-Nürnberg</td>
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<td>18:00</td>
<td>501-502</td>
<td>We4C-3: Noninvasive Continuous Blood Pressure Monitoring Based on Wearable Radars with Preliminary Clinical Validation</td>
<td>L. Ren, SJTU; S. Dong, SJTU; Z. Zhang, Shanghai General Hospital; C. Gu, SJTU; J. Mao, SJTU</td>
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<td>18:10</td>
<td>503-504</td>
<td>We4D-3: Sub-mW 30GHz Variable-Gain LNA in 22nm FDSOI CMOS for Low-Power Tapered mm-wave 5G/6G Phased-Array Receivers</td>
<td>M. Spasaro, Aarhus Univ.; D. Zito, Aarhus Univ.</td>
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<td>18:20</td>
<td>401-402</td>
<td>We4A-4: Dual-Resonance mmWave Antenna Matching Network Comprised of Separated Ground Layers and Via Posts for Adjustable Return Current Path Modification</td>
<td>Y. Youn, POSTECH; J. Choi, LG Innotek; B. Kim, POSTECH; W. Hong, POSTECH</td>
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<td>18:30</td>
<td>403-404</td>
<td>We4B-4: 3D Printed Wideband High-Power X-Band Radial Combiner</td>
<td>N. Lopez, MIT Lincoln Laboratory; A.E. Fathy, Univ. of Tennessee; M.D. Aboouzahra, MIT Lincoln Laboratory; J. Blandford, MIT Lincoln Laboratory; R. Kazemi, Univ. of Tennessee; C.J. Baudier, Univ. of Tennessee; C. Eckert, MIT</td>
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<td>18:40</td>
<td>501-502</td>
<td>We4C-4: Measurement of Displacement Motions Based on Unsynchronized Bandpass Sampling with a Low-IF Doppler Radar</td>
<td>F. Tong, SJTU; J. Liu, SJTU; C. Gu, SJTU; J. Mao, SJTU</td>
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We4F-1: A 75GHz Dynamic Antenna Array for Real-Time Imageless Object Detection via Fourier Domain Filtering


We4F-2: Incoherent Point Spread Function Estimation and Multipoint Deconvolution for Active Incoherent Millimeter-Wave Imaging


We4F-3: Received Signal Strength Estimation in Indoor Environment using High Frequency Ryton Approximation

Amartansh Dubey, Hong Kong Univ. of Science and Technology; Samruddhi Deshmukh, The Hong Kong Univ. of Science and Technology; Dingfei Ma, The Hong Kong Univ. of Science and Technology; Ross Murch, The Hong Kong Univ. of Science and Technology

We4F-4: A 300-1300MHz Single Antenna Digital-FMCW Ground Penetrating Radar with Switched-Gain Calibration to Improve Dynamic Range

A. Tang, Jet Propulsion Lab; E. Decrossas, Jet Propulsion Lab; Y. Gilm, Jet Propulsion Lab; R. Beauchamp, Jet Propulsion Lab; S. Culacli, Jet Propulsion Lab

We4F-5: Thickness Profile Estimation of Fluid-Carrying Non-Metallic Pipes

M.B. Shah, NYIT; Y. Gao, NYIT; M. Ravan, NYIT; R.K. Arinieh, NYIT

We4G-1: High-Gain 670-6GHz Amplifier Circuits in InGaAs-on-InSulator HEMT Technology


We4G-2: A 300–1300MHz Single-Stage FET Amplifier for 2G and 3G Scenarios

M. B. Shah, NYIT; S. Vakalis, NYIT; M. Ravan, NYIT

We4G-3: A New 77GHz Sampling Mixer in 28nm FD-SOI CMOS Technology for Automotive Radar Application

S. Kwon, Yonsei Univ.; M. Jung, Univ. of California, San Diego; B.-W. Min, Yonsei Univ.

We4G-4: A 190-to-220GHz 4-Bit Passive Attenuator with 1.4dB Insertion Loss and Sub-0.4dB RMS Amplitude Error Using Magnetically Switchable Coupled-Lines in 0.13um CMOS Technology

N. Zhu, Tianjin Univ.; F. Meng, Tianjin Univ.

We4G-5: A Novel OTA Near-Field Measurement Approach Suitable for 5G mmWave Wideband Modulated Tests

J. Vriens, D. DeWire, Hermetic Solutions

We5F-1: Planetary Poster: Earth Observation with Microwave Radiometers – Miniaturization and AI-based Solutions

Pekka Kangaslahti, Shannon Brown, Javier Bosch-Lluis, Sid Misra, Shaminie Padmanabhan, Jet Propulsion Lab; Bill Deal, Northrop Grumman Corp.

We5F-10: Characterization and Estimation of EVM Hump Based on Transmitter AM-AM and AM-PM Characteristics

S. Farsi, Meta; Y. Wang, W. Al-Ahmad, Samsung

We5F-11: Analysis and Experiments of the Impact of Frequency Ramp Nonlinearity on Range Resolution and Accuracy in LFM-CW Radar

Z. Zhang, J. Liu, C. Gu, J. Mao, SJTU

We5F-12: 5.8GHz Highly Sensitive and Linear Doppler Radar Using Digital Self-Injection-Locking Technology


We5F-13: Cost-Efficient Baseband DPD for Hybrid MIMO Systems with Shallow Learning Artificial Neural Networks

P. Jueschke, T. Stedile-Ribeiro, Nokia; G. Fischer, FAU Erlangen-Nuremberg

We5F-14: Cumulative Mill Rolled Pd Foil Based Hs Getter for Improving Microwave Device Reliability

H. Xia, J. Vrensen, D. DeWire, Hermetic Solutions Group

We5F-15: A Flexible Implementation of Ka-Band Active Phased Array for Satellite Communication


We5G-1: Novel MMIC Negative Group Delay Transrsal Filter-Based Negative Capacitor in 0.1um GaAs pHEMT Technology


We5G-2: Compact Asymmetrical Voltage-Mode Doherty PA with 30% Bandwidth and 80Watt Output Power

E. Heidebrecht, R. Negro, RWTH Aachen Univ.

We5G-3: Ultra-Wideband Microstrip to Substrate Integrated Waveguide (SIW) Vertical Transition

A. Zerfaine, T. Djerfati, IMRS-EMT

We5G-4: A Novel High Power Plastic Quad Flat No-Lead Package Structure for RF GaN Applications

S.-C. Hsiao, J.-C. Chiu, P.-K. Tseng, Y.-C. Lai, C.-W. Huang, WIN Semiconductors

We5G-5: Reducing FDD MMU Form Factor with Active Cancellation


We5G-6: 10W High Efficiency GaN-Si MMIC Power Amplifier for 17.3–20GHz Onboard Satellite Use

P. Colantonio, Università di Roma “Tor Vergata”; M. Lopez, L. Cabria, TTI North; F. Virbi, REA; R. Gielke, Università di Roma “Tor Vergata”

We5G-7: A Plenary Poster: Earth Observation with Microwave Radiometers — Miniaturization and AI-based Solutions

Pekka Kangaslahti, Shannon Brown, Javier Bosch-Lluis, Sid Misra, Shaminie Padmanabhan, Jet Propulsion Lab; Bill Deal, Northrop Grumman Corp.

We5G-8: Novel Waveguide Connectors to Simplify Microwave and Millimeterwave Component Packaging

A. Zerfaine, T. Djerfati, IMRS-EMT

We5G-9: 10W High Efficiency GaN-Si MMIC Power Amplifier for 17.3–20GHz Onboard Satellite Use

P. Colantonio, Università di Roma “Tor Vergata”; M. Lopez, L. Cabria, TTI North; F. Virbi, REA; R. Gielke, Università di Roma “Tor Vergata”

We6F-1: Interactive Forum Session & Interactive Forum Reception

Room: 2A–3B

We6F-2: 15:10 – 17:00

Room: 2A–3B
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<td>WEMA31</td>
<td>09:30 – 9:45</td>
<td>Passive Circuit Analysis and Model Development for Silicon Chips Using EMX 3D Planar Solver</td>
<td>Nikolas Provatas, Cadence</td>
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<tr>
<td>WEMA32</td>
<td>09:45 – 10:00</td>
<td>Phase Noise Measurements from Advanced R&amp;D to Production</td>
<td>Matt Maxwell, Rohde &amp; Schwarz</td>
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<td>WEMA33</td>
<td>10:00 – 10:15</td>
<td>Realtime VNA Measurement Uncertainty Accuracy</td>
<td>Rich Pieciak, Rohde &amp; Schwarz GmbH &amp; Co KG</td>
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<td>WEMA34</td>
<td>10:15 – 10:30</td>
<td>RF Filters for Space Applications</td>
<td>Tim Brauner, Knowles Precision Devices</td>
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<td>WEMA35</td>
<td>10:30 – 10:45</td>
<td>Selecting Microwave Electromechanical Switches for ATE Applications</td>
<td>Krzysztof Ciezarek, Microwave Products Group</td>
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<td>WEMA36</td>
<td>10:45 – 11:00</td>
<td>Single Sweep Broadband S-Parameter Measurements to mm-wave for Semiconductor Transistor and IC Test to 220 GHz</td>
<td>Gavin Fisher, FormFactor</td>
</tr>
<tr>
<td>WEMA37</td>
<td>11:00 – 11:15</td>
<td>Summing Power: Power Combining Trade-Offs and Requirements</td>
<td>Shaun Moore, TRM Microwave</td>
</tr>
<tr>
<td>WEMA38</td>
<td>11:15 – 11:30</td>
<td>TFLE-Thin Film Lumped Elements Reflective and Non-Reflective Filtering Solutions</td>
<td>Rafi Hershtig, K&amp;L Microwave</td>
</tr>
<tr>
<td>WEMA39</td>
<td>11:30 – 11:45</td>
<td>VNA Application Solutions for S-parameter Measurements in Large Test Setups</td>
<td>Navneet Kataria, Anritsu Co.</td>
</tr>
<tr>
<td>WEMA40</td>
<td>11:45 – 12:00</td>
<td>VSWR, Return Loss, and the Best Directivity Money Can Buy</td>
<td>Doug Jorgesen, Marki Microwave</td>
</tr>
<tr>
<td>WEMA41</td>
<td>12:00 – 12:15</td>
<td>10MHz-30GHz USB-Configurable Front-End Module</td>
<td>Sidina Wane, eVTechnologies; Joel Kirshman, StarWave-US LLC</td>
</tr>
<tr>
<td>WEMA42</td>
<td>12:15 – 12:30</td>
<td>16-port RF-mmW USB-Controlled Switch Matrix and Correlator</td>
<td>Sidina Wane, eVTechnologies; Joel Kirshman, StarWave-US LLC</td>
</tr>
<tr>
<td>WEMA43</td>
<td>12:30 – 12:45</td>
<td>A New Miniature Atomic Clock for Ruggedized C5ISR Applications</td>
<td>Stavros Melachroinos, Orolia</td>
</tr>
<tr>
<td>WEMA44</td>
<td>12:45 – 13:00</td>
<td>Fast Switching, High Performance PLL and Quadband VCO Frequency Synthesizer</td>
<td>Kieran Barrett, Analog Devices, Inc.</td>
</tr>
<tr>
<td>WEMA45</td>
<td>13:00 – 13:15</td>
<td>GaN Nonlinear Large Signal Model — A Necessary Tool for 1st Pass Power Amplifier Design Success</td>
<td>Yueying Liu, Cree Semiconductor</td>
</tr>
<tr>
<td>WEMA46</td>
<td>13:15 – 13:30</td>
<td>Microwave Signal Generators with Improved Phase Noise and Frequency Stability</td>
<td>Alexander Chenakin, Suresh Ojha, Sadashiv Phadnis, Anritsu Company</td>
</tr>
<tr>
<td>WEMA48</td>
<td>13:45 – 14:00</td>
<td>PA Design Using Nonlinear Embedding Models</td>
<td>Chris DeMartino, Modelithics</td>
</tr>
<tr>
<td>WEMA49</td>
<td>14:00 – 14:15</td>
<td>XMA: Advancements Within Quantum Enabling RF Technologies and Challenges Moving Forward</td>
<td>Del Pierson, XMA Corporation</td>
</tr>
<tr>
<td>WEMA50</td>
<td>14:15 – 14:30</td>
<td>Aerogel Film as a Microwave Substrate</td>
<td>John Gardner, Blueshift</td>
</tr>
<tr>
<td>WEMA51</td>
<td>14:30 – 14:45</td>
<td>Single Connection Frequency Converter Measurements</td>
<td>Rich Pieciak, Rohde &amp; Schwarz GmbH &amp; Co KG</td>
</tr>
<tr>
<td>WEMA52</td>
<td>14:45 – 15:00</td>
<td>5G NR Challenges and Trends in RFFE Design</td>
<td>Peter Bacon, pSemi, a Murata Company</td>
</tr>
<tr>
<td>WEMA53</td>
<td>15:00 – 15:15</td>
<td>5G Private and Non-Terrestrial Network Design</td>
<td>Paul Moakes, CommAgility</td>
</tr>
<tr>
<td>WEMA54</td>
<td>15:15 – 15:30</td>
<td>A New MIMO Over-the-Air Test Methodology using Dynamic Channel Models and Link Adaptation</td>
<td>Michael Foegelle, ETS-Lindgren</td>
</tr>
<tr>
<td>WEMA55</td>
<td>15:30 – 15:45</td>
<td>Achieve Best EVM Performance for Modulated Signals in the Millimeter Wave Range</td>
<td>Melanie Mauersberger, Rohde &amp; Schwarz</td>
</tr>
<tr>
<td>WEMA56</td>
<td>15:45 – 16:00</td>
<td>Achieving Multi Gbps Data Rates in Non-terrestrial Applications</td>
<td>Tudor Williams, Filtronic</td>
</tr>
<tr>
<td>WEMA57</td>
<td>16:00 – 16:15</td>
<td>Automatic Configuration of Modulation Quality Measurements for DVB-S2(X) and -RCS2 Signals</td>
<td>Florian Ramian, Rohde &amp; Schwarz GmbH &amp; Co KG</td>
</tr>
<tr>
<td>WEMA58</td>
<td>16:15 – 16:30</td>
<td>Characterize Faster Phased Array Antennas Over-The-Air Using Fast Continuous Scanning</td>
<td>Gerardo Orozco, N (National Instruments)</td>
</tr>
<tr>
<td>WEMA59</td>
<td>16:30 – 16:45</td>
<td>Cutting Through the “Fog” to Join High-Bandwidth Edge Sensors with the Secure Cloud Using the Latest SoC Technology</td>
<td>Bob Muro, Mercury Systems</td>
</tr>
<tr>
<td>WEMA60</td>
<td>16:45 – 17:00</td>
<td>DC to 64Gbps Micro Relay with Integrated Driver, A Simplified Solution to Increase Productivity</td>
<td>Eric Carty, Analog Devices</td>
</tr>
</tbody>
</table>

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## MTT-S AWARDS

### Microwave Career Award recognizes a career of meritorious achievement and outstanding technical contribution by an individual in the field of microwave theory and techniques.

- **Wolfgang J. R. Hoefer** — for a career of leadership, meritorious achievement, creativity and outstanding contributions in the field of microwave theory and techniques.

### Microwave Pioneer Award recognizes an individual or a team not exceeding three persons having made outstanding pioneering technical contributions that advance microwave theory and techniques, which are described in an archival paper published at least 20 years prior to the year of the award.

- **Kenneth Carr** — for outstanding contributions in the field of microwave theory and techniques.

### Distinguished Service Award recognizes an individual who has given outstanding service for the benefit and advancement of the MTT Society.

- **Madhu S. Gupta** — for outstanding contributions in the field of microwave theory and techniques.

### Distinguished Educator Award recognizes a distinguished educator in the field of microwave engineering and science who best exemplifies the special human qualities of Fred Rosenbaum, who considered teaching a high calling and demonstrated his dedication to the Society through tireless service.

- **Ke Wu** — for outstanding achievements as an educator, mentor, and role model of microwave engineers and engineering students.

### Microwave Application Award Recognizes an individual or team of no more than five individuals for an outstanding application of microwave theory and techniques, which has been reduced to practice nominally 10 years before the award.

- **Matthew A. Morgan** — for the creation of a new class of reflectionless filters.

### Outstanding Young Engineer Award recognizes an outstanding young MTT-S member who has distinguished him/herself through achievement(s), which may be technical (within the MTT-S Field of Interest), may be exemplary service to the MTT-S, or may be a combination of both.

- **Anthony Ghiootto** — for outstanding early career achievements in substrate integrate waveguide technologies and exemplary service to the society.
- **Xun Luo** — for outstanding early career achievements in the field of microwave passive and integrated circuits with applications in wireless communication.
- **Bodhisatwa Sadhu** — for outstanding early career contributions to RF and millimeter-wave circuits and systems.
- **Alexis Zamora** — for outstanding early career contributions to the solid-state terahertz field.

## MTT-S BEST PAPER AWARDS

### Microwave Prize recognizes, on an annual basis, the most significant contribution by a published paper to the field of interest of the MTT-S. The Microwave Prize is the Society’s oldest Award.


### MCWL “Tatsuo Itoh” Award recognizes, on an annual basis, the most significant contribution in a paper published in the *IEEE Microwave and Wireless Components Letters*.


### T-TST Best Paper Award recognizes, on an annual basis, the most significant contribution in a paper published in the *IEEE Transactions on Terahertz Science and Technology*.


### IEEE Microwave Magazine Best Paper Award recognizes, on an annual basis, the most significant contribution in a paper published in the *IEEE Microwave Magazine*.

ADVANCED PRACTICE AND INDUSTRY PAPER COMPETITIONS

The Advanced Practice Paper Competition (APPC) recognizes outstanding technical contributions that apply to practical applications. All finalist papers are on advanced practices and describe an innovative RF/microwave design, integration technique, process enhancement, and/or combination thereof that results in significant improvements in performance and/or in time to production for RF/microwave components, subsystems, or systems.

The Industry Paper Competition (IPC) recognizes outstanding technical contributions from industry sources. All finalist papers are from the RF/microwave industry and describe innovation of a product or system application that potentially has the highest impact on an RF/microwave product and/or system which will significantly benefit the microwave community and society at large.

ADVANCED PRACTICE PAPER FINALISTS:

**Th2F:** A 32-Element 28/39 GHz Dual-Band Dual-Beam 5G Phased-Array with 40 dBm EIRP and Simultaneous 64-QAM Operation  
*Authors:* Shufan Wang, Univ. of California; San Diego; Gabriel Rebeiz, Univ. of California, San Diego

**We2A:** Miniaturized 28 GHz Packaged Bandpass Filter with High Selectivity and Wide Stopband Using Multi-Layer PCB Technology  
*Authors:* Yunbo Rao, Univ. of Electronic Science and Technology of China; Huizhen Qian, Univ. of Electronic Science and Technology of China; Jie Zhou, Univ. of Electronic Science and Technology of China; Yuandian Dong, Univ. of Electronic Science and Technology of China; Xun Luo, Univ. of Electronic Science and Technology of China

**We2C:** Deep Learning Enabled Inverse Design of 30-94 GHz Psat-3dB SiGe PA Supporting Concurrent Multi-Band Operation at Multi-Gbps  

INDUSTRY PAPER FINALISTS:

**We1E:** A 50W CW 1-6 GHz GaN MMIC Power Amplifier Module with Greater than 30% Power Added Efficiency  
*Authors:* Michael Roberg, QORVO, Inc.; Jason Zhang, QORVO, Inc.; Robert Flynt, QORVO, Inc.; Matthew Irvine, QORVO, Inc.

**Tu4A:** A 31-Tap Reconfigurable Analog FIR Filter Using Heterogeneously Integrated Polystrata Delay-Lines  
*Authors:* Eric Wagner, Northrop Grumman Corp.; Tim LaRocca, Northrop Grumman Corp.; Mark Verderber, Nuvotronics; Carlos Rezende, Nuvotronics; Peter May, Nuvotronics

**Th1B:** A Reconfigurable SAW Resonator Using Monolithically Integrated Switches  
*Authors:* Arash Fouladi Azarnaminy, Univ. of Waterloo; Aminat Oyiza Suleiman, Institut National de la Recherche Scientifique; Mohamed Chaker, Institut National de la Recherche Scientifique; Raafat Mansour, Univ. of Waterloo

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- **2nd Prize**—Beats Noise Cancelling Headphones and mophie 4-in-1 Universal Charging Mat
- **3rd Prize**—Echo Show 8 and Sonos Roam

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1D-1F

Th1F: Efficient Characterization and Test of Phased-Array Antenna Systems: Is it Really a Nightmare?*

Chair: Marc Vanden Bossche, National Instruments
Co-Chair: Matt Spexarth, National Instruments

Th1F-1: Keynote: Calibrating RF/Microwave Front Ends in Multichannel Receiver and Transmitter Systems
Mike Jones, Analog Devices, Inc.

Th1F-2: Rydberg Atomic Electrometry: A Near-Field Technology for Complete Far-Field Imaging in Seconds?
D. Booth, Quantum Valley Ideas Laboratories; K. Nickerson, Quantum Valley Ideas Laboratories; S. Bohaichuk, Quantum Valley Ideas Laboratories; J. Erskine, Quantum Valley Ideas Laboratories; J.P. Shaffer, Quantum Valley Ideas Laboratories

Th1F-3: A Novel OTA Near-Field Measurement Approach Suitable for 5G mmWave Wideband Modulated Tests
M. Löhning, National Instruments; T. Deckert, National Instruments; V. Kotzsch, National Instruments; M. Vanden Bossche, National Instruments

Th1F-4: Fast Simultaneous Characterization of All Analog Phased Array Elements
M.D. Foegelle, ETS-Lindgren

Th1F-5: Preliminary System Integration and Performance Features for an S-Band, Dual-Polarized, All-Digital Phased Array Radar
C. Fulton, Univ. of Oklahoma; N. Goodman, Univ. of Oklahoma; M. Yeary, Univ. of Oklahoma; R. Palmer, Univ. of Oklahoma; H.H. Sigmarsson, Univ. of Oklahoma; J. McDaniel, Univ. of Oklahoma

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<th>Time</th>
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<th>Title</th>
<th>Chair(s)</th>
<th>Authors/Institutions</th>
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<tr>
<td>10:10</td>
<td>Th2A-1</td>
<td>3D Chip-Level Broadband Measurement Technique for Radiated EM Emission</td>
<td>Y.-C. Chang, NARLabs-TSR; J. Wang, National Tsing Hua Univ.; T.-Y. Lin, NARLabs-TSR; C.-P. Hsieh, NARLabs-TSR; Y. Huang, Univ. of Liverpool; S.S.H. Hsu, National Tsing Hua Univ.; D.-C. Chang, NARLabs-TSR</td>
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<tr>
<td>10:30</td>
<td>Th2A-2</td>
<td>Linearity Metrics and Signal Statistics — The Need for Standards</td>
<td>R. Figueiredo, Universidade de Aveiro; N. Carvalho, Universidade de Aveiro</td>
<td></td>
</tr>
<tr>
<td>10:40</td>
<td>Th2A-3</td>
<td>A 110 GHz Comb Generator in a 250 nm InP HBT Technology</td>
<td>Jerome Cheron, Dylan Williams, Richard Chamberlin, National Institute of Standards and Technology; Miguel Urteaga, Telefónica; Paul Hale, Rob Jones, Ari Feldman, National Institute of Standards and Technology</td>
<td></td>
</tr>
<tr>
<td>10:50</td>
<td>Th2A-4</td>
<td>Silicon Micromachined Metrology Components for 0.5–1.1Hz</td>
<td>J. Campion, TeraSi; B. Beuerle, TeraSi</td>
<td></td>
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<tr>
<td>11:40</td>
<td>Th2B-2</td>
<td>Miniaturized Ultrawide Bandwidth WiFi 6E Diplexer</td>
<td>S. Gupta, Akoustis; E. MehdiZadeh, Akoustis; K. Cheema, Akoustis; J.B. Shealy, Akoustis</td>
<td></td>
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<tr>
<td>12:10</td>
<td>Th2B-4</td>
<td>Wideband Hybrid Acoustic-Electromagnetic Filters with Prescribed Chebyshev Functions</td>
<td>G. Ariturk, Univ. of Oklahoma; N.R. Almuqati, Univ. of Oklahoma; Y. Yu, Texas Instruments; E.T. Yen, Texas Instruments; A. Fruhling, Texas Instruments; H.H. Sigmansson, Univ. of Oklahoma</td>
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<tr>
<td>12:20</td>
<td>Th2B-5</td>
<td>5-Band High Passive Gain Resonant Transformers Based on Aluminum Nitride FBAR Resonators</td>
<td>Y.-M. Huang, National Tsing Hua Univ.; C.-Y. Chang, National Tsing Hua Univ.; T.-H. Hsu, National Tsing Hua Univ.; Y. Ho, VIS; Y.-H. Chen, VIS; Y.R. Pradeep, VIS; R. Chaud, VIS; S.-S. Li, National Tsing Hua Univ.; M. Wang, National Tsing Hua Univ.; M. H. Li, National Tsing Hua Univ.</td>
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<tr>
<td>12:40</td>
<td>Th2C-1</td>
<td>28nm Neck Width Graphene Geometric Diode for THz Harvesting</td>
<td>H. Wang, KAUST; A. Shamim, KAUST</td>
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<td>12:50</td>
<td>Th2C-2</td>
<td>Self-Consistent and Full-Wave Analysis of Carbon-Nanotube Matrices for Multi-Channel Charge Confinement</td>
<td>D. Mencarelli, Università Politecnica delle Marche; G.M. Zampa, Università Politecnica delle Marche; C.H. Joseph, Università Politecnica delle Marche; L. Pierantoni, Università Politecnica delle Marche</td>
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<td>13:10</td>
<td>Th2C-3</td>
<td>Towards 500GHz Non-Volatile Monolayer 6G Switches</td>
<td>M. Kim, UNIST; G. Docoumau, IEMN (UMR 8520); S. Skrzypczak, IEMN (UMR 8520); P. Sznitgiser, PHILAM (UMR 8523); S.J. Yang, Univ. of Texas at Austin; N. Wainstein, Technion; C. Stern, Technion; H. Happy, IEMN (UMR 8520); E. Yalon, Technion; E. Palacci, IEMN (UMR 8520); D. Akinwande, Univ. of Texas at Austin</td>
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<tr>
<td>13:30</td>
<td>Th2C-5</td>
<td>Integrated CNT Aerogel Absorbers for Sub-THz Waveguide Systems</td>
<td>P.A. Dródź, Polish Academy of Sciences; J. Campion, KTH; N. Xenidis, KTH; A. Krajewska, Polish Academy of Sciences; A. Przewłoka, Polish Academy of Sciences; S. Sminov, KTH; M. Haras, Polish Academy of Sciences; A. Nasibulin, Aalto Univ.; D.V. Lioubtchinko, Polish Academy of Sciences</td>
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<td>13:50</td>
<td>Th2C-7</td>
<td>Long-Term Large-Signal RF Reliability Characterization of SiGe HBTs Using a Passive Impedance Tuner System</td>
<td>C. Weimer, Technische Universität Dresden; E. Vardari, Technische Universität Dresden; G.G. Fischer, IHP; M. Schröter, Technische Universität Dresden</td>
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1D-1F
Th2F: Antenna Systems for 5G and SATCOM Applications Dedicated to Ferdo Ivanek
Chair: Robin Garg, MediaTek, Inc.
Co-Chair: Julio Navarro, Boeing

Th2F-1: 16–52GHz 5G Transmit and Receive 64-Element Phased-Arrays with 50–51.7dBm Peak EIRP and Multi-Gb/s 64-QAM Operation
A. Alhamed, Univ. of California, San Diego; G. Gultepe, Univ. of California, San Diego; G.M. Rebeiz, Univ. of California, San Diego

Th2F-2: A Ka-Band Transmit Phased-Array Antenna-in-Package for SATCOM-on-the-Move User Terminals
A. Raseei, Univ. of Waterloo; N. Ghafari, Univ. of Waterloo; W.M. Abdel-Wahab, Univ. of Waterloo; A. Palizban, Univ. of Waterloo; A. Ehsandar, Univ. of Waterloo; E. Alian, Univ. of Waterloo; M.-R. Nezhad-Ahmadi, Univ. of Waterloo; S. Safavi-Naeini, Univ. of Waterloo

Th2F-3: Implementation and Far-Field Calibration of an 8×8 37–40GHz Phased Array with Vivaldi Aperture
G. Lasser, Univ. of Colorado Boulder; A. Samaiyar, Ansys; G.R. Friedrichs, Univ. of Colorado Boulder; L.B. Boskovic, Univ. of Colorado Boulder; M.A. Elmansouri, Univ. of Colorado Boulder; D.S. Filipovic, Univ. of Colorado Boulder

Th2F-4: Dual-Input Digital Predistortion of Millimeter-Wave RF Beamforming Arrays Driven by Two Non-Contiguous Intra-Band Signals
A. Ben Ayed, Univ. of Waterloo; Y. Cao, Univ. of Waterloo; P. Mitran, Univ. of Waterloo; S. Boumaiza, Univ. of Waterloo

Th2F-5: A 32-Element 28/39GHz Dual-Band Dual-Beam 5G Phased-Array with 40dBm EIRP and Simultaneous 64 QAM Operation
S. Wang, Univ. of California, San Diego; G.M. Rebeiz, Univ. of California, San Diego

Th2F-6: A 1024-Element Ku-Band SATCOM Phased-Array Transmitter with 39.2dBW EIRP and ±53° Beam Scanning

There’s Still Time
to visit the IMS Show Floor before it closes at 15:00!

Stop by one of the networking lounges (Booths 3110, 4058 and 11068) on the IMS Show Floor, catch up with colleagues, and charge your device.
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<tr>
<td>THMA61</td>
<td>09:30 - 09:45</td>
<td>Highly Accurate RF System Modeling</td>
<td>Chris DeMartino, Modelithics</td>
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<tr>
<td>THMA62</td>
<td>09:45 - 10:00</td>
<td>High-Performance or Low-Cost Signal Generation: Why Accept That Trade-Off?</td>
<td>Bob Buxton, Boonton</td>
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<tr>
<td>THMA63</td>
<td>10:00 - 10:15</td>
<td>High-Rate Sample Clocks for Wideband RF Systems</td>
<td>Raymond Baker, Richardson RFQ</td>
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<td>THMA64</td>
<td>10:15 - 10:30</td>
<td>Improve Speed for Modulated Test in Characterization and Production</td>
<td>Markus Loemer, Rohde &amp; Schwarz USA, Inc.</td>
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<td>THMA65</td>
<td>10:30 - 10:45</td>
<td>Improving RF Performance for Base Transceiver Stations and Automotive Designs with Highly Reliable, High Power Handling, Ultra-Low Insertion Loss RF Switches</td>
<td>Joe Simanis, Nishinbo Micro Devices</td>
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<tr>
<td>THMA66</td>
<td>10:45 - 11:00</td>
<td>Need sub-10fs RMS Jitter Signal Generation: Translation Loops</td>
<td>Unal Kudret, Analog Devices, Inc.</td>
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<td>THMA67</td>
<td>11:00 - 11:15</td>
<td>The Technical Challenges of Employing GaN and How to Overcome Them</td>
<td>Tudor Williams, Filtronic</td>
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<td>THMA68</td>
<td>11:15 - 11:30</td>
<td>Using Commercial Instruments to Record and Playback Interference Signals</td>
<td>Alejandro Buritica, Andrew Cobas, Tektronix</td>
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<td>THMA69</td>
<td>11:30 - 11:45</td>
<td>Performance of Marki Microwave Components in Quantum Information Systems</td>
<td>Harley Berman, Marki Microwave</td>
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<tr>
<td>THMA70</td>
<td>11:45 - 12:00</td>
<td>Strategies for Enabling Quantum Development with Test and Measurement from 77K down to milli-Kelvin</td>
<td>Jack DeGrave, FormFactor</td>
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<tr>
<td>THMA71</td>
<td>12:00 - 12:15</td>
<td>Tunable and Fixed Filtering Solutions Enhances Dynamic Range and Flexibility of 4G-5G-LTE Characterization Measurements</td>
<td>Rafi Hershtig, K&amp;L Microwave</td>
</tr>
<tr>
<td>THMA72</td>
<td>12:15 - 12:30</td>
<td>WIPL-D Domain Decomposition Solver: 12 Million Unknowns — One Server — One Day</td>
<td>Miodrag Tasic, Univ. of Belgrade, Branko Kolundzija, WIPL-D</td>
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<tr>
<td>THMA73</td>
<td>13:00 - 13:30</td>
<td>Drawing for winners of IMS2022 Mini Golf Classic!</td>
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5G TESTING – ARE YOU READY?

5G will change the way we communicate. 5G NR is the first communications standard designed to support a wide variety of consumer and industry applications. 3GPP release 15 laid the foundation for 5G NR by introducing new, flexible numerology, advanced channel coding and modulation schemes. Enabling wider channel bandwidths and extended carrier aggregation schemes while also extending frequencies into the millimeter wave range make more radio resources available. In this book, five Rohde & Schwarz experts for wireless communications technologies give insights into 5G NR.

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**13:30 - 15:10**

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- **Active Components**
- **Systems & Applications**
- **Emerging Technologies & Applications**
- **Focus & Special Sessions**

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**401-402**

**Th3A: MHz-to-THz Instrumentation for Biological Measurements and Applications**

**Chair:** Olga Boric-Lubecke, Univ. of Hawaii at Manoa

**Co-Chair:** Tomislav Markovic, Univ. of Zagreb

**Th3A-1: A 0.43g Wireless Battery-less Neural Recorder with On-chip Microelectrode Array and Integrated Flexible Antenna**

- Hengying Shan, Purdue Univ.; John Peterson III, Purdue Univ.; Nathan Conrad, Purdue Univ.; Y. Tang, Purdue Univ.; Yuhang Zhu, Purdue Univ.; Shabnam Ghobi, Purdue Univ.; Sutton Hathorn, Purdue Univ.; Alexander Chubykin, Purdue Univ.; Saeed Mohammadi, Purdue Univ.

**Th3A-2: UHF-Diethrocystophoresis Signatures as a Relevant Discriminant Electromagnetic Biomarker of Colorectal Cancer Stem Cells**

- E. Lambert, XLIM (UMR 7252);
- E. Barthout, CAPtuR (EA 3842);
- R. Manczak, XLIM (UMR 7252);
- S. Sadaa, B. Bassette, M. Mathonnet, F. Lallioué, CAPtuR (EA 3842);
- C. Dalmay, A. Pothier, XLIM (UMR 7252)

---

**403-404**

**Th3B: Emerging Phase-Change and SiW Technologies for mm-Wave to Sub-THz Applications**

**Chair:** John Ebel, AFRL

**Co-Chair:** Tejinder Singh, Dell Technologies

**Th3B-1: A W-Band Photoconductive Exanescent-Mode Waveguide Switch**

- T.R. Junes, Univ. of Alberta; A. Fisher, Purdue Univ.; D.W. Barlage, Univ. of Alberta; D. Peroulis, Purdue Univ.

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**501-502**

**Th3C: Silicon Based Digital Power Amplifier Architectures**

**Chair:** Mark P. van der Heijden, NXP Semiconductors

**Co-Chair:** Sushil Kumar, Marki Microwave

**Th3C-1: A Large Dynamic Range Reconfigurable Interpolation Digital Receiver for 110-bit Applications**

- Nagarajan Mahalingam, Hang Liu, Yisheng Wang, Kiat Seng Yeo, Singapore Univ. of Technology and Design; Chien-I Chou, Hung-Yu Tsai, Kun-Hsun Liao, Wen-Shan Wang, Ke-Ui Chan, Ying-Hsi Lin, Realtek Semiconductor Corp.

---

**1A - 1C**

**Th3E: Reconfigurable RF Systems for 5G mm-Wave Communications**

**Chair:** Hoigel Maune, OvG Universität Magdeburg

**Co-Chair:** Nathan Orloff, NIST

**Th3E-1: Slow-Wave MEMS Phase Shifter with Liquid Crystal for Reconfigurable 5G**

- L. Gomes, Universidade de São Paulo;
- D. Wang, Technische Univ. Darmstadt;
- G. Palominio, J. Lé, Universidade de São Paulo;
- R. Jakoby, Technische Univ. Darmstadt;
- H. Maune, OvG Universität Magdeburg;
- P. Ferrari, RFC-Lab (EA 7520);
- A.L. Serrano, G.P. Rehder, Universidade de São Paulo

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**501-502**

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**403-404**

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- T.R. Junes, Univ. of Alberta; A. Fisher, Purdue Univ.; D.W. Barlage, Univ. of Alberta; D. Peroulis, Purdue Univ.

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**401-402**

**Th3A: MHz-to-THz Instrumentation for Biological Measurements and Applications**

**Chair:** Olga Boric-Lubecke, Univ. of Hawaii at Manoa

**Co-Chair:** Tomislav Markovic, Univ. of Zagreb

**Th3A-1: A 0.43g Wireless Battery-less Neural Recorder with On-chip Microelectrode Array and Integrated Flexible Antenna**

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1D-1F
Th3F: Advances in Integrated Transceivers for Beamforming and RADAR Applications
Chair: Jonathan P. Commeau, Anokiwave
Co-Chair: Najme Ebrahimi, Univ. of Florida

Th3F-1: A 28GHz Butler Matrix Based Switched Beam-Forming Network with Phase Inverting Switch for Dual-Port Excitation in 28nm CMOS
Y. Lee, Yonsei Univ.; B. Suh, Samsung; B.-W. Min, Yonsei Univ.

Th3F-2: A 1.9dB NF K-Band Temperature-Healing Phased-Array Receiver Employing Hybrid Packaged 65nm CMOS Beamformer and 0.1μm GaAs LNAs
Dixian Zhao, Peng Gu, Jiajun Zhang, Yongran Yi, Mengru Yang, Chenyu Xu, Southeast Univ.; Yuan Chai, Huiji Liu, Pingyang He, Na Peng, Chengdu Xphased Technology Company Ltd.; Liangliang Liu, Xiangzi Yan, Purple Mountain Laboratories; Xiaohu You, Southeast Univ.

Th3F-3: A Fully-Integrated CMOS System-on-Chip Ku Band Radiometer System for Remote Sensing of Snow and Ice
A. Tang, Univ. of California, Los Angeles; Y. Kim, Stevens Institute of Technology; M.-C.F. Chang, Jet Propulsion Lab

13:30 13:40 13:50 14:00 14:10 14:20 14:30 14:40 14:50 15:00 15:10
The microwave and RF design engineer always seeks to develop a design that will meet specifications the first time that the circuit is fabricated. To do so requires that as many elements and phenomenon as possible associated with the control devices and circuit be accurately modeled. In the case of the microwave and RF semiconductor control circuits, accurate modeling of the solid-state control components over frequency, voltage, current and power is key to successful control system design. This talk will cover material that will provide the RF and microwave design engineer insight into the physical operation and modeling of PIN diodes and field-effect transistors (FETs) as control components and their use in microwave and RF control circuits. The talk will cover basic RF and microwave control circuits for reconfigurable electronics, and then focus on linear and nonlinear models for PIN diode, MESFET and MOSFET control elements to implement these circuits. The talk will conclude with control circuit examples using these models for use in reconfigurable RF and microwave electronics.
INTERACTIVE FORUM SESSION & PHASED ARRAYS AND OTA DAY RECEPTION

13:30 – 15:30 Thursday, 23 June 2022
Room: 2A–3B

Chairs: Akim Babenko, Justus Brevik, Robert Horansky, NIST

THIF3-1: Plenary Poster: Full-Duplex Phased Arrays: Multi-Function Applications and Enabling Technologies
Kenneth Kelebezej, Massachusetts Institute of Technology, Lincoln Laboratory

THIF3-2: A 40Gbps QAM-16 Communication Link Using a 130nm SiGe BiCMOS Process
F. Strömbeck, Y. Yan, Z.S. He, H. Zirath, Chalmers University of Technology

THIF3-3: An Octave Bandwidth Spatial Power Combiner with Supply Voltage Control
L. Marzall, C. Nogales, G. Lasser, Z. Popovic, Univ. of Colorado Boulder

THIF3-4: Laser-Based Noncontact Blood Pressure Estimation Using Human Body Displacement Waves
Y. Oyamada, T. Koshisaka, Kyoto Univ.; G. Stankaitis, Univ. of Hawaii at Manoa; S.M.M. Islam, Univ. of Dhaka; V.M. Lubecke, O. Boric-Lubecke, Univ. of Hawaii at Manoa; T. Sakamoto, Kyoto Univ.

THIF3-5: Time Domain-Based Reflectometry Measurements for 3D Printed Graded Index Dielectrics
P. Bluem, R.G. Rojas, B. Duncan, D. Beck, MIT Lincoln Laboratory

THIF3-6: Reference Measurements of Error Vector Magnitude
P. Manurkar, Univ. of Colorado Boulder; C.P. Silva, Aerospace; J. Kast, Colorado School of Mines; R.D. Horansky, D.F. Williams, K.A. Remley, NIST

THIF3-7: Investigations on Direction of Arrival and Range Estimation with a Switched Beam Antenna Architecture Implementing Space and Frequency Division Multiple Access
A. Cidronali, G. Colliodi, S. Maddio, M. Passafiume, G. Pelosi, Università di Firenze

THIF3-8: 180GHz Low-Loss Copper Nanowire CPW Interconnects
A. Dawe, Y. Zhang, Univ. of Minnesota; N. Mahjabeen, Univ. of Texas at Dallas; A. Harpel, Univ. of Minnesota; R. Henderson, Univ. of Texas at Dallas; B. Stadler, R.R. Franklin, Univ. of Minnesota

E. Guerrero, L. Acosta, Univ. Autònoma de Barcelona; C. Caballero, J. Verdú, Univ. Autònoma de Barcelona; A. Guerrero, IMB-CN; X. Bomisè, ICIN2; J. Esteve, IMB-CN; P. de Paco, Univ. Autònoma de Barcelona

THIF3-10: Low-Bias-Complexity Ku-Band GaN MMIC Doherty Power Amplifier
G. Naah, Università di Roma “Tor Vergata”; A. Piacibello, V. Camarchia, Politecnico di Torino; P. Colantonio, R. Giehlé, Università di Roma “Tor Vergata”

THIF3-11: Long-Range Vital Sign Monitoring by Using a W Band Heterogeneously Integrated FMCW Radar Sensor
Y.-S. Huang, X. Yang, L. Zhou, C. Gu, J. Mao, SJTU

THIF3-12: Waveguide Iris Sensor with Thermal Modulation for Non-Intrusive Flow Rate Measurements
D. Niskan, A. Shah, M.H. Zafri, Univ. of British Columbia

---

INDUSTRY WORKSHOPS

10:10 – 15:10 Thursday, 23 June 2022

<table>
<thead>
<tr>
<th>SESSION CODE</th>
<th>TIME &amp; LOCATION</th>
<th>TITLE AND ABSTRACT</th>
<th>SPEAKER/S, AFFILIATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>IWTH2</td>
<td>10:10 - 11:50</td>
<td>Emerging EMC Require</td>
<td>Garth D’Abreu, ETS-Lindgren; Jason Coder, NIST; Aurelian Bria, Ericsson; Jari Vikstedt, ETS-Lindgren</td>
</tr>
<tr>
<td></td>
<td>Room: 205/207</td>
<td>ments for 5G mmWave Device Measurements</td>
<td>Achieving electromagnetic compatibility (EMC) for 5G devices is dependent upon the existence of achievable and appropriate regulatory requirements along with meaningful test methods for demonstrating compliance. This workshop will investigate new developments in test methods, focused on meeting the regulatory requirements of the FCC but with global application, with presentations focused on wireless coexistence and radiated emissions test methods. An overview of wireless coexistence measurements and challenges is presented followed by a focus on automotive applications. This is followed by an overview of emerging radiated emissions test methods and research on utilizing a reverberation methodology for faster TRP measurements.</td>
</tr>
<tr>
<td>IWTH3</td>
<td>13:30 - 15:10</td>
<td>Materials Characterization and Assessment for 5G/ mmWave Applications</td>
<td>Malgorzata Celuch, QWED Sp. z o.o.; Say Phommakesone, Keysight Technologies; Marzena Olszewska-Plach, QWED Sp. z o.o.; Urmie Ray, iNEMI; Nate Orloff, Lucas Enright, NIST</td>
</tr>
<tr>
<td></td>
<td>Room: 205/207</td>
<td>The Workshop discusses the iNEMI 5G benchmarking activity of materials’ characterization techniques relevant to 5G/mmWave applications. Four measurement methods (SCR, SPDR, BCDR, FPOR) have been identified and tested in a round-robin of 10 sample kits (including Precision Teflon, COP, and fused silica) circulated between 10 laboratories. The experimental results will be presented and the physics of the measurement process will be illustrated with FDTD, FEM, and MoM simulations. The Workshop comprises four 15-minute lectures (5G industry needs; benchmarked methods and EM insight; round-robin results; best practices and recommendations) followed by 45-minute hands-on exercises and 15-minute discussion.</td>
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</table>
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Learning from the Lightning: How Nikola Tesla Formulated a Scheme for Wireless Power in Colorado Springs

IMS KEYNOTE SPEAKER:

Prof. W. Bernard Carlson, Vaughan Professor of Humanities, Department of Engineering and Society, Univ. of Virginia and TechInnovate, National Univ. of Ireland Galway

ABSTRACT: Nikola Tesla [1856-1943] is frequently celebrated for inventing a practical AC motor and for contributing to early radio technology through his plans to transmit power wirelessly around the world. This lecture will trace how Tesla developed his wireless technology from 1890 to 1905, with an emphasis on what he learned in 1899 when he operated an experimental station in Colorado Springs. Since his station was located on Colorado’s Front Range, Tesla was able to watch thunderstorms as they moved out of the Rockies and across the Great Plains and to study the ground currents generated by lightning strikes. These observations allowed Tesla to confirm his theory of how to transmit energy through the earth’s crust but at the same time he failed to challenge or disconfirm this theory, a failure that limited his subsequent efforts to perfect his ambitious plan for wireless power. Nonetheless, while in Colorado Tesla perfected his understanding of how to tune his transmitting and receiving circuits, thus laying the groundwork for future development of radio technology.

BIOGRAPHY: Bernie Carlson is the Joseph L. Vaughan Professor of Humanities and lectures in the TechInnovate program at the National Univ. of Ireland Galway. Bernie studied history and physics as an undergraduate at Holy Cross College, earned his Ph.D. in the history and sociology of science at the Univ. of Pennsylvania, and did his postdoctoral work at the Harvard Business School. He has written widely on invention and innovation as well as on the role of technology in the rise and fall of civilizations. His books include Innovation as a Social Process: Elihu Thomson and the Rise of General Electric, 1870-1900 (Cambridge Univ. Press, 1991) and Technology in World History, 7 volumes (Oxford Univ. Press, 2005). His most recent book, Tesla: Inventor of the Electrical Age (Princeton Univ. Press, 2013) has been translated into nine languages. In addition to his books, Bernie has filmed 36 lectures on “Understanding the Inventions that changed the World” for The Great Courses. He is a regular contributor to Forbes.com, writing on innovation and the modern economy. Bernie has been the recipient of the IEEE History Fellowship and winner of both the SHOT-IEEE History Prize and the Middleton Award in Electrical History. With the IEEE, he has served on the advisory board of Spectrum and chaired the History Committee.
**99TH ARFTG MICROWAVE MEASUREMENT CONFERENCE**

From Fundamental to Cutting-Edge Microwave Measurement Techniques to Support 6G and Beyond

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<table>
<thead>
<tr>
<th>08:00 – 08:10</th>
<th>Welcome to the 99th ARFTG Conference — Introduction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conference Co-Chairs:</strong> Jeffrey Jargon and Marco Spirito</td>
<td></td>
</tr>
<tr>
<td><strong>TPC Co-Chairs:</strong> Andrej Rumiantsev and Marc Vanden Bossche</td>
<td></td>
</tr>
</tbody>
</table>

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**08:10-08:50**

**Keynote:** Characterizing Cryogenic Josephson Microwave Sources for Communications and Quantum Information

Alirio S. Boaventura (NIST)*

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**Session A: Enabling Wideband Characterization Techniques**

*Session Chair: Patrick Roblin*

**A-1**

<table>
<thead>
<tr>
<th>08:50 – 09:10</th>
</tr>
</thead>
<tbody>
<tr>
<td>VNA-Based Testbed for Accurate Linearizability Testing of Power Amplifiers Under Modulated Signals</td>
</tr>
<tr>
<td><strong>Nizar Messaoudi, Keysight Technologies</strong>; <strong>Ahmed Ben Ayed, Univ. of Waterloo</strong>; <strong>Jean-Pierre Teysseyer, Keysight Technologies</strong>; <strong>Slim Boumaiza, Nil</strong></td>
</tr>
</tbody>
</table>

**A-2**

<table>
<thead>
<tr>
<th>09:10 – 09:30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wideband Vector Corrected Measurements on a Modified Vector Network Analyzer, VNA System</td>
</tr>
<tr>
<td><strong>Christoph Schulze, Ferdinand-Braun-Institut</strong>; <strong>Wolfgang Heinrich, Ferdinand-Braun-Institut</strong>; <strong>Joel Dunsmore, Keysight Technologies</strong>; <strong>Olof Bengtsson, Ferdinand-Braun-Institut, Leibniz-Institut für Höchstfrequenztechnik</strong></td>
</tr>
</tbody>
</table>

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**09:30 – 11:00 | BREAK – EXHIBITS AND INTERACTIVE FORUM**

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**Session B: mmWave Over-the-Air Characterization**

*Session Chair: Rusty Myers*

**B-1**

<table>
<thead>
<tr>
<th>11:00 – 11:20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traceable mmWave Modulated-Signal Measurements for OTA Test</td>
</tr>
<tr>
<td><strong>Joshua M. Kast, Colorado School of Mines</strong>; <strong>Paritosh Manurkar, Univ. of Colorado Boulder</strong>; <strong>Kate Remley, NIST</strong>; <strong>Rob Horansky, NIST</strong>; <strong>Dylan Williams, NIST</strong></td>
</tr>
</tbody>
</table>

**B-2**

<table>
<thead>
<tr>
<th>11:20 – 11:40</th>
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</thead>
<tbody>
<tr>
<td>On Coupling-related Distortion Behavior in mm-Wave Phased Arrays</td>
</tr>
<tr>
<td><strong>Jon Martens, Anritsu</strong></td>
</tr>
</tbody>
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**B-3**

<table>
<thead>
<tr>
<th>11:40 – 12:00</th>
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</thead>
<tbody>
<tr>
<td>D-band Free Space Dielectric Characterization of a Low-Cost Ultradense Microdiamond Composite for Heat Spreading</td>
</tr>
<tr>
<td><strong>Shu-Ming Chang, UCSB</strong>; <strong>Chelsea Swank, UCSD</strong>; <strong>Andrew Kummel, UCSD</strong>; <strong>Muhannad Bakir, Georgia Tech</strong>; <strong>Mark Rodwell, UCSB</strong>; <strong>James Buckwalter, UCSB</strong></td>
</tr>
</tbody>
</table>

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**12:00 – 13:30 | AWARDS LUNCHEON**

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**Session C: Non-Linear, Large-Signal and VNA Techniques**

*Session Chair: Mauro Marchetti*

**C-1**

<table>
<thead>
<tr>
<th>13:30 – 13:50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local-Oscillator Third-Harmonic Injection for Improved Broadband Mixer Linearity</td>
</tr>
<tr>
<td><strong>Akim A. Babenko, Anritsu</strong>; <strong>Jon Martens, Anritsu</strong></td>
</tr>
</tbody>
</table>

**C-2**

<table>
<thead>
<tr>
<th>13:50 – 14:10</th>
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</thead>
<tbody>
<tr>
<td>Surmounting W-band Scalar Load-Pull Limitations Using the ASM-HEMT Model for Millimeter-Wave GaN HEMT Technology Large-Signal Assessment</td>
</tr>
<tr>
<td><strong>Nicholas C. Miller, Air Force Research Laboratory</strong>; <strong>Michael Elliott, SelectTech Services</strong>; <strong>Ryan Gilbert, KBR</strong>; <strong>Erdem Arkun, HRL Laboratories</strong>; <strong>Daniel Denninghoff, HRL Laboratories</strong></td>
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</tbody>
</table>

**C-3**

<table>
<thead>
<tr>
<th>14:10 – 14:30</th>
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<tbody>
<tr>
<td>Impact of Broadband Modulation in Active Load-Pull On-Wafer Measurements of GaN HEMTs</td>
</tr>
<tr>
<td><strong>Alberto Maria Angelotti, Univ. of Bologna</strong>; <strong>Gian Gibiino, Univ. di Bologna</strong>; <strong>Troels Nielsen, Keysight Technologies, Inc.</strong>; <strong>Alberto Santarelli, Univ. of Bologna</strong>; <strong>Jan Verspecht, Keysight Technologies, Inc.</strong></td>
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**C-4**

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<tbody>
<tr>
<td>Effective AM/AM and AM/PM Curves Derived from EVM Measurements on Constellations</td>
</tr>
<tr>
<td><strong>Jacques B. Sombrin, TESA Laboratory</strong></td>
</tr>
</tbody>
</table>

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| 14:50 – 16:00 | BREAK – EXHIBITS AND INTERACTIVE FORUM |
**Session D: On-Wafer Techniques**
Session Chair: Leonard Hayden

| **D-1** 16:00–16:20 | Parasitic Coupling Effects in Coplanar Short Measurements  
Gia Ngoc Phung, Physikalische Technische Bundesanstalt*; Uwe Arz, Physikalisch-Technische Bundesanstalt, PTB |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------|
| **D-2** 16:20–16:40 | Extending the Open-Short De-embedding Frequency via M1 On-Wafer Calibration Approaches  
Ciro Esposito, TU Dresden* |
| **D-3** 16:40–17:00 | Wideband mm-Wave Integrated Passive Tuners for Accurate Characterization of BICMOS Technologies  
Marc Margalef-Rovira, IEMN Laboratory*; Caroline Maye, IEMN Laboratory; Sylvie Lepilliet, IEMN Laboratory; Daniel Gloria, STMicroelectronics; Guillaume Ducournau, IEMN Laboratory; Christophe Gaquiere, MC2-Technologies |

**Interactive Forum**
Session Chair: Marc Vanden Bossche

| **P-1** 09:30–15:40 | Demonstration of Non-invasive Probing of CMOS Devices with Aluminum Pads at Frequencies up to 500 GHz  
Ryo Sakamaki, National institute of Advanced Industrial Science and Technology*; Ryoko Kishikawa, National Institute of Advanced Industrial Science and Technology; Seitaro Kon, AIST; Yuya Tojima, AIST; Ichiro Somada, Mitsubishi Electric Company; Shunpei Matsui, Hiroshima Univ.; Gakuto Taoka, Hiroshima Univ.; Takeshi Yoshida, Hiroshima Univ.; Shuhei Amakawa, Hiroshima Univ.; Minoru Fujishima, Hiroshima Univ. |
| **P-2** 09:30–15:40 | Determination of the Coplanar Waveguide Propagation Constant via Non-contact, On-wafer Measurements in WR1.5 Band  
Mitch Wallis, NIST*; Charles Little, NIST; Richard Chamberlin, NIST; George Burton, NIST; Nathan Orloff, NIST; Christian Long, NIST; Kubilay Sertel, TeraProbes Inc |
| **P-3** 09:30–15:40 | A Single-Element CMOS-LRRM VNA Electronic Calibration Technique  
Jun-Chau Chien, National Taiwan Univ.*; Ali Niknejad, Univ. of California Berkeley |
| **P-4** 09:30–15:40 | The w-plane as a Graphical Representation of Sampler Configuration in a Sampled-Network Reflectometer  
Devon Donahue, Univ. of Colorado Boulder*; Taylor Barton, Univ. of Colorado Boulder |
Lei Li, Cornell Univ.* |

Closing Notes – End of 99th ARFTG Conference

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**Cheers to 70 Years!**

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**MTT-S**
IEEE Microwave Theory & Technology Society

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**FRIDAY**

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<tr>
<th>Company Name</th>
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<td>2pi-Labs GmbH</td>
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<td>3D Glass Solutions Inc</td>
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<td>3G Shielding Specialties</td>
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<td>6015</td>
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<td>3RVAPE</td>
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<td>10058</td>
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<td>A-Alpha Waveguide Inc</td>
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<td>ACE-Accurate Circuit Engineering</td>
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<td>ACEWAVETECH</td>
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<td>Advanced Circuity International</td>
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<td>Advanced Test Equipment Corp</td>
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<td>11081</td>
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<td>7018</td>
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<td>ALMT Corp.</td>
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