Inaugural Editorial

WELCOME to the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY! Our primary goal is to bring together in one forum the diverse, global communities that make up terahertz science and techniques. Our mission statement, "*Expanding the Use of the Electromagnetic Spectrum*" is consistent with our roots in the engineering community and expresses our desire to extend science and technology into applications for the betterment of humankind. The transactions targets high impact papers with broad appeal to the rapidly expanding terahertz community. The high standards of the IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES will be maintained, but the scope of these transactions will extend to fields and activities that are outside of the traditional RF and microwave society. We are pledged to provide a high quality, comprehensive publication that spans a wide spectrum of terahertz activities and developments, while at the same time helping to bridge the technology gap between the RF and photonics communities. A personal goal of the editor-in-chief is to enrich the readers' experience by exposure to cross disciplinary developments in the field that they might otherwise miss. The IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY brings together in a single focused journal, the very broad range of topics and technologies that encompass THz techniques and applications. The editorial board is organized by topic area and has a primary goal of reviewing submitted papers and deciding on publication status within three months. Accepted papers will be posted on-line on *IEEEXplore* within approximately six weeks of final acceptance. This rapid posting of high-quality papers will bring new ideas more quickly to the fore and stimulate discussion and distribution without compromising the peer review process. In keeping with the varied scope of the THz field, the topical editors of the transactions will frequently re-evaluate their emphasis and update their committee members to intelligently respond to trends and to the suggestions of the transactions contributors and readers.

The release of this **Inaugural Print Issue** and simultaneous electronic posting, follows a comprehensive solicitation and review process that was intended to give the reader a broad introduction to the THz field with a large number of overview and review papers on THz technologies and applications from notable researchers. Future issues will follow an open submission process with accepted papers appearing on the IEEEXplore site prior to release of the print copy. As can be seen from the list of 26 technical paper titles in the Table of Contents, the **Inaugural Issue** covers devices and instruments, basic science, a diverse range of applications as well as general and specific measurement techniques. There are papers from astronomers, chemists, physicists, engineers, biochemists, physicians, and even art historians. They come from university, industry, private, and government research groups worldwide. Although we have many disciplines and application areas represented, there are equally as many we have not been able to include. These will be sprinkled into future issues as will highlighted papers from the various THz conferences that support our diverse community. A continuing special interest feature, "THz Pioneers" has been included to help introduce new researchers to those individuals who have had long term contributions and major impact on the THz field.

The editorial board, as well as the many individuals within the IEEE Microwave Theory and Techniques Society, who have been working very hard behind the scenes for more than a year to bring this publication to fruition, sincerely hope you will find IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY useful, relevant, and most important, stimulating to your research and development efforts and a positive contribution to your career development. We all hope the publication serves your interests, and that in turn you will serve the interests of the THz community by considering the Transactions a primary outlet for your ideas, your inventions, and your reporting.

Yours sincerely,

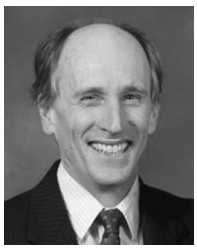
PETER H. SIEGEL, *Editor-in-Chief*
Jet Propulsion Laboratory and
California Institute of Technology
Pasadena, CA 91109 USA
(e-mail: phs@caltech.edu)

Peter H. Siegel (S'77–M'83–SM'98–F'01) received the B.A. degree from Colgate University, in 1976, and the Ph.D. degree from Columbia University, in 1983.

He holds appointments as Faculty Associate in Electrical Engineering and Senior Scientist in Biology at Caltech and Senior Research Scientist and Technical Group Supervisor for Submillimeter Wave Advanced Technology (SWAT), Jet Propulsion Laboratory , Pasadena, CA. He has been working in the areas of millimeter and submillimeter-wave technology and applications for 35 years and has PI'd or co-I'd more than 75 R&D programs and been involved in four major space flight instruments. He has published more than 275 articles in the THz field and has given more than 75 invited talks in the U.S. and abroad on this subject. At JPL,he leads a group of 20+ research scientists and engineers developing THz technology for NASA's near and long term space missions as well as for several DoD applications. At Caltech, he is involved in new biological and medical applications of THz. His current interests are split between traditional Earth, planetary and astrophysics applications and new THz applications in medicine and biology.

Among many other duties, Dr. Siegel chairs the International Society for Infrared, Millimeter and Terahertz Waves (IRMMW-THz), the oldest and largest venue devoted to the field of far-IR techniques, science and applications, and he served as conference organizer and chair for IRMMW-THz 2008 in Pasadena. He has served as an IEEE Distinguished Microwave Lecturer, co-chair and chair of MTT Committee 4-THz Technology, a TPC and Speaker's bureau member, and as organizer and chair of seven special sessions at the IEEE International Microwave Symposia. He is extremely pleased, and very excited to be involved in the formation and launching of the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY. (His Web Page: http://www.thz.caltech.edu.)

Digital Object Identifier 10.1109/TTHZ.2011.2162013



Dylan F. Williams (M'80–SM'90–F'02) received the Ph.D. degree in electrical Engineering from the University of California, Berkeley in 1986. He joined the Electromagnetic Fields Division of the National Institute of Standards and Technology, Boulder, CO, in 1989, where he develops electrical waveform and microwave metrology. He has published over 80 technical papers.

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A. Giles Davies received the B.Sc. degree in chemical physics from the University of Bristol, Bristol, U.K., in 1987, and the Ph.D. degree in semiconductor physics from the University of Cambridge, Cambridge, U.K., in 1991.

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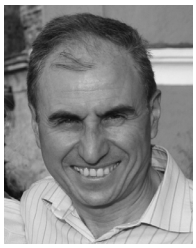
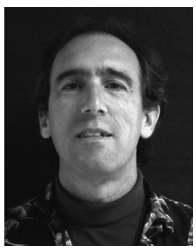


Gian Piero Gallerano received the Ph.D. degree in physics from the University of Rome, Italy, in 1980, with a thesis on the realization of a tunable color center laser in the near infrared.

In 1981 he was a Visiting Fellow at the Technical University Hannover, Germany. In 1983 he joined the High Power Laser Laboratory , ENEA Research Center, Frascati, Italy, to work on the development of infrared free electron lasers (FEL). In 1991 he was a Visiting Scholar at the Ginzton Laboratory, EE Department, Stanford University, CA. His work on FELs lead to the realization of the ENEA Compact FEL (90–150 GHz) and of the Compact Advanced THz Source, FEL-CATS (0.4–0.7 THz). From 2001 to 2004 he has been the Coordinator of the European project THz-BRIDGE involving ten research institutes in the study the interaction of THz radiation with biological systems. From 2005 to 2007 he has been in charge of the ENEA participation in the European project EUROFEL. He is currently the Head of the Radiation Sources Laboratory at ENEA Frascati. His areas of interest include generation of THz radiation and its application in the biological, biomedical, environmental and art conservation fields, THz imaging techniques, coherent emission from RF modulated electron beams, free electron lasers, optical design and diagnostics in the infrared. He has published over 100 papers in international journals.

Dr. Gallerano has chaired the "35th International Conference on Infrared, Millimeter and THz Waves" IRMMW-THz 2010 held in Rome, Italy, September 5–10, 2010. He has been a member of the Italian Physical Society since 1981 and is currently an associate member of the Bioelectromagnetics Society.



Erich N. Grossman received the A.B. degree in physics from Harvard College, Cambridge, MA, in 1980, and a Ph.D. degree, also in physics, from the California Institute of Technology, Pasadena, in 1987. His thesis work involved development of an ultra-low noise, heterodyne receiver for 2 THz astronomy.

From 1988 to 1989, he was a post-doctoral fellow at the University of Texas at Austin, and in 1989, he joined the National Institute of Standards and Technology, Boulder, CO, where he is now a physicist in the Optoelectronics Division. His work at NIST focuses on infrared and submillimeter system development.

Dr. Grossman's notable accomplishments include the development and demonstration of the world's highest frequency, high efficiency lithographic antennas, the world's highest frequency Josephson junctions, (awarded a Department of Commerce Gold Medal in 1993), and early conception and development of the SQUID multiplexer, first enabling large monolithic arrays of superconducting detectors. More recently, he has developed several 0.1–1 THz cameras for security applications. He is also chair of the Metrology Working Group for the DARPA Terahertz Electronics program.

Peter Uhd Jepsen (M'10) received the M.Sc. degree in physics and chemistry from Odense University, Denmark, in 1994, and the Ph.D. degree in natural sciences from Århus University, Denmark in 1996.

He was at the University of Freiburg, Germany from 1996 to 2004, working with terahertz time-domain spectroscopy. From 2005 he was Associate Professor at the Technical University of Denmark (DTU), and since 2008 Professor and Head of the Terahertz Technologies and Biophotonics group at DTU. In 2008/2009 he was Visiting Professor at Osaka University. His research areas include photonics-based THz technology, broadband THz spectroscopy for chemical sensing, imaging, chemistry, and water dynamics in the THz range, and time-resolved THz spectroscopy of ultrafast phenomena in the THz range.

Kodo Kawase received B.S. degree in electronic engineering from Kyoto University in 1989, and Ph.D degree in electronic engineering from Tohoku University in 1996.

He became an Initiative Researcher at RIKEN in 2001. He became a Professor of Graduate School of Engineering, Nagoya University, Japan, in 2005. He has been conducting research activities in several directions within the THz field. He developed several types of widely tunable THz sources using nonlinear optical effects, and suggested a whole range of real-life applications. He has published more than 130 articles in the THz field and has given more than 160 invited talks on this subject.

Dr. Kawase received the 1997 Young Scientist Award from the JSAP, the 1998 Excellent Presentation Award, the 2000 and 2006 Prize of Laser Engineering from the Laser Society of Japan, the 2002 Marubun research and encouragement award and 2006 Marubun Special Research Award by the Marubun Research Promotion Foundation (MRPF), and the the 2005 Young Scientists' Prize by the Commendation for Science and Technology by the Minister of Education, Culture, Science and Technology (MEXT).

Martin Koch was born in Marburg, Germany in 1963. He received the Diploma and Ph.D. degree form the University of Marburg in 1991 and 1995, respectively.

From 1995 to 1996 he was a post-doctorate at Bell Labs/Lucent Technologies, Holmdel, NJ. From 1996 to 1998 worked in the photonics and optoelectronics group at the University of Munich. From 1998 to 2008 he was associate professor at the Technical University of Braunschweig. In 2003, he did a three-month sabbatical at the University of California in Santa Barbara. Since 2009 he is full professor of physics at the Philipps University Marburg, Germany. His research interests are terahertz systems and their applications, semiconductor disk lasers and ultrafast spectroscopy on semiconductors.

In 2003, Dr. Koch was awarded the Kaiser-Friedrich Research Prize.

Nuria Llombart received the Electrical Engineering degree and Ph.D. degree from the Polytechnic University of Valencia, Spain, in 2002 and 2006 respectively.

During her Master's degree studies she spent one year at the Friedrich-Alexander University of Erlangen-Nuremberg, Germany, and worked at the Fraunhofer Institute for Integrated Circuits, Erlangen, Germany. From 2002 until 2007, she was with the Antenna Group at the TNO Defence, Security and Safety Institute, The Hague, The Netherlands, working as Ph.D. student and afterwards as researcher. From 2007 until 2010, she was a Post-Doctoral Fellow at the California Institute of Technology, working for the Sub millimeter Wave Advance Technology group of the Jet Propulsion Laboratory (JPL), Pasadena, CA. Currently, she holds a "Ramón y Cajal" fellowship at the Optics Department of the Complutense University of Madrid, Spain, while she continues to be an affiliate at JPL, Pasadena. Her research interests include the analysis and design of planar antennas, periodic structures, reflector antennas, lens antennas, waveguide structures, with emphasis in the THz range.

Dr. Llombart was co-recipient of the H. A. Wheeler Award for the Best Applications Paper of 2008 in the IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION. She was also a co-recipient of an Honorable Mention at the 2010 European Conference of Antennas. She serves as Topical Editor for the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

Imran Mehdi (F'10) received the B.S.E.E. degree in 1985, the M.S.E.E. degree in 1986, and the Ph.D . degree in 1990, all from the University of Michigan.

He is currently Principal Member of Engineering staff at the Jet Propulsion Laboratory, California Institute of Technology, Pasadena. His responsibilities include developing THz components and subsystems for current and future NASA missions. He joined JPL in 1990 where his first task included the design and fabrication of low-parasitic planar Schottky diodes for submillimeter-wave applications. These devices were implemented on the ozone monitoring Microwave Limb Sounder instrument which is still operational, as well as the MIRO instrument which represents the first submillimeter-wave receiver that will rendezvous with a comet in 2014. From 1999, he led the effort of developing broadband solid-state sources from 200 to 2500 GHz for the Heterodyne Instrument for Far Infrared (HIFI) on the Herschel Space Observatory, a cornerstone European Space Agency mission currently in space. This effort led to realization of wide-band solid-state sources in the THz range enabling ground-breaking astrophysics observations in space as well as at many ground-based observatories. His current interests include both mm and sub-mm wave devices, semiconductor fabrication technology, high-frequency instrumentation, and heterodyne receivers for miniature systems.

Gun-Sik Park (M'06) received the B.S. degree in physics education from Seoul National University in Korea and the Ph.D degree in physics from the University of Maryland, College Park, in 1978 and 1989, respectively.

During 1987—1995, he worked at Naval Research Laboratory, Washington, DC, through Omega-P, Inc. In 1995, he joined Seoul National University and currently is a Professor in the Department of Physics and Astronomy, and also jointly with the Department of Electrical Engineering at Seoul National University. He leads the Center for THz-Bio Application Systems (2009—2018) at Seoul National University supported by the Ministry of Education, Science and Technology of Korea as a Director. His service to journal editor includes *Journal of Korean Physical Society* (JKPS), *Journal of New Physics*, and the *THz Science and Technology*. He serves as a topical editor for IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY, and as a technical committee member of IEEE Electron Devices Society in Vacuum Electronics since 1999. He was a conference chair for 4th IEEE International Vacuum Electronics Conference in 2003 held in Korea and is a co-chair for 34th International Conference on Infrared, Millimeter, and Terahertz Waves in 2009 held in Korea. He is the author of over 100 journal publications in the areas of high power microwaves to terahertz waves.

Christopher Walker has over 25 years experience designing, building, and using state-of-the-art receiver systems for THz astronomy. He is a Professor of Astronomy and an Associate Professor of Optical Sciences and Electrical Engineering at the University of Arizona (UofA). He has worked in industry (TRW Aerospace and JPL) as well as academia. As a Millikan Fellow in Physics at Caltech, he worked on the development of low-noise, SIS waveguide receivers above 400 GHz and explored techniques for etching waveguide out of silicon. On joining the UofA faculty in 1991 he began the Steward Observatory Radio Astronomy Lab (SORAL), which has become a world leader in developing THz receiver systems for astronomy and other remote sensing applications. These instruments are multi-institutional efforts, with key components coming from JPL, several universities, and a number of industrial partners. He manages and coordinates these efforts. Instruments developed by Prof. Walker's team have served as primary facility instruments at the Heinrich Hertz Telescope on Mt. Graham, AZ, and the AST/RO telescope at the South Pole. He is leading the effort to design and build the world's largest (64 pixels) submillimeter-wave heterodyne array receiver (SuperCam). He is also PI of the NASA funded long duration balloon project "The Stratospheric THz Observatory (STO)". He has published numerous papers on star formation and protostellar evolution. He has served as dissertation director for nine Ph.D. students.

Editorial

WELCOME to this second issue of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY! This is our first *regular* issue release and it contains unsolicited papers from a range of authors working on terahertz devices, components, instruments, measurement techniques and applications. All of these papers were submitted and then taken through a rigorous review and acceptance process, well before the completion and release of our September 2011 Inaugural Issue, and hence, before any of the contributing authors had seen even a preliminary version of the journal. I would like to personally thank all the authors who were willing to preview their research in our brand new publication under such circumstances. It is both a sign of support from the international science community for this new Terahertz Transactions, as well as a testimony to the follow-through of the IEEE Microwave Theory and Techniques Publications Committee and all the T-THz Topic Editors and Review Board members who have pledged their time and energy to bring this publication to life.

Our first *Call for Papers* was released more than one year ago. In that call, we promised to provide the THz community with a high quality, comprehensive publication that spans a wide spectrum of terahertz activities and developments, while at the same time helping to bridge the technology gap between the RF and photonics communities. We remain committed to that goal. This November 2011 issue is made up of papers from RF engineering, astronomy, communications and device physics. Our "THz Pioneers" series highlights the career of noted solid-state physics professor, Dr. Paul Richards, and coincidently there are three accompanying articles on THz superconducting detectors. The release of this first *regular* issue officially launches our new publication as a continuing long-term commitment to the THz community.

We sincerely hope you will find IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY (T-THz) relevant, informative and most important, stimulating to your research efforts and a positive contribution to your career development. We all hope the publication serves your interests, and that in turn you will serve the interests of the THz community by considering the Terahertz Transactions a primary outlet for your ideas, your inventions, and your reporting.

TOPIC AREAS, TOPIC EDITORS, AND KEYWORDS

1. **THz applications in astronomy, space, and environmental science—***Chris Walker*
   Keywords: Gas spectroscopy, Earth science, cosmic background, planetary science, heterodyne instruments, low noise detectors, imaging arrays.

2. **THz applications in biology and medicine** *—Gian Piero Gallerano*
   Keywords: Biological and medical imaging and spectroscopy, RF interactions with tissues, safety and exposure studies, medical diagnostics, clinical instruments, biochemistry studies, hydration and water-protein interactions, biomaterials modeling, clinical studies.

3. **THz applications in chemistry and spectroscopy** *—P. Uhd Jepsen*
   Keywords: Chemical analysis and fingerprinting, ultrafast chemistry, pump-probe experiments and instrumentation, spectral methods and analysis, material properties.

4. **THz plasma science and instruments**—*Stefano Alberti*
   Keywords: Gyrotrons, BWO, TWT, FEL, coherent RF sources by intense electron beams, DNP-NMR spectroscopy, EPR spectroscopy, RF plasma diagnostics, quasi-optical techniques, imaging using plasma techniques.

5. **THz radar and communications—***Erich Grossman*
   Keywords: Radar imaging, spectroscopy and motion techniques and instrumentation, transceivers, point-to-point communications and LAN, telecommunication devices and optical-to-RF conversion, high speed digital electronics.

6. **THz industrial and nondestructive evaluation** *—Martin Koch*
   Keywords: Industrial and non destructive imaging, spectroscopy and monitoring, industrial process control, commercial packaging and reliability, commercial applications, near field microscopy, imaging and spectroscopy.

7. **THz devices and components—***Imran Mehdi and Jack East*
   Keywords: Active and passive semiconductor and superconductor devices and circuits, two and three terminal devices, wafer processing and materials, solid-state and vacuum sources and sensors, gas laser sources, quantum-well devices.

8. **THz photonics—***Giles Davies*
   Keywords: Quantum cascade lasers, photonic devices and systems, optoelectronic devices, photonic crystals, near field photonics based imaging, solid-state and semiconductor lasers.

9. **THz nonlinear optics, optical based sources and imaging—***René Beigang and Kodo Kawase*
   Keywords: Nonlinear optics, optical based sources and imaging, laser pumped sources, parametric sources, difference frequency generation, phase matching techniques.

Digital Object Identifier 10.1109/TTHZ.2011.2167173

10. **THz beam forming and guided structures—***Nuria Llombart-Juan*
Keywords: Beamforming networks, quasi-optics, pulse and CW transmission and transmission media, quasi-optical measurement and analysis techniques.

11. **THz modeling and analysis techniques—***Gun-Sik Park*
Keywords: Numeric techniques, theory and analysis of devices, circuits, observable phenomena, predicted device and instrument performance and sensitivity, image analysis and enhancement, circuit analysis, EM simulator techniques and models.

Yours sincerely,

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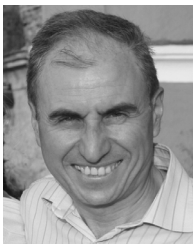

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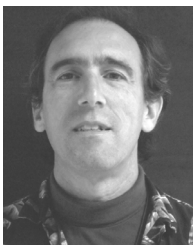

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Gun-Sik Park (M'06) received the B.S. degree in physics education from Seoul National University in Korea and the Ph.D degree in physics from the University of Maryland, College Park, in 1978 and 1989, respectively.

During 1987–1995, he worked at Naval Research Laboratory, Washington, DC, through Omega-P, Inc. In 1995, he joined Seoul National University and currently is a Professor in the Department of Physics and Astronomy, and also jointly with the Department of Electrical Engineering at Seoul National University. He leads the Center for THz-Bio Application Systems (2009–2018) at Seoul National University supported by the Ministry of Education, Science and Technology of Korea as a Director.

Dr. Parks' service to journal editor includes *Journal of Korean Physical Society* (JKPS), *Journal of New Physics*, and the *THz Science and Technology*. He serves as a topical editor for IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY, and as a technical committee member of IEEE Electron Devices Society in Vacuum Electronics since 1999. He was a conference chair for 4th IEEE International Vacuum Electronics Conference in 2003 held in Korea and is a co-chair for 34th International Conference on Infrared, Millimeter, and Terahertz Waves in 2009 held in Korea. He is the author of over 100 journal publications in the areas of high power microwaves to terahertz waves.

Christopher Walker has over 25 years experience designing, building, and using state-of-the-art receiver systems for THz astronomy. He is a Professor of Astronomy and an Associate Professor of Optical Sciences and Electrical Engineering at the University of Arizona (UofA). He has worked in industry (TRW Aerospace and JPL) as well as academia. As a Millikan Fellow in Physics at Caltech, he worked on the development of low-noise, SIS waveguide receivers above 400 GHz and explored techniques for etching waveguide out of silicon. On joining the UofA faculty in 1991 he began the Steward Observatory Radio Astronomy Lab (SORAL), which has become a world leader in developing THz receiver systems for astronomy and other remote sensing applications. These instruments are multi-institutional efforts, with key components coming from JPL, several universities, and a number of industrial partners. He manages and coordinates these efforts. Instruments developed by Prof. Walker's team have served as primary facility instruments at the Heinrich Hertz Telescope on Mt. Graham, AZ, and the AST/RO telescope at the South Pole. He is leading the effort to design and build the world's largest (64 pixels) submillimeter-wave heterodyne array receiver (SuperCam). He is also PI of the NASA funded long duration balloon project "The Stratospheric THz Observatory (STO)". He has published numerous papers on star formation and protostellar evolution. He has served as dissertation director for nine Ph.D. students.

Editorial

WE HAVE REACHED our third issue of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY and a much anticipated milestone for this Editor-in-Chief. This is the start of our first full year of regular issues, and the first issue in Volume 2 of our fledgling journal. I have personally pledged to provide a minimum of six full issues in 2012, to be released on a bi-monthly basis beginning with this January's Issue number 1. With your continued support, we will move to 12 regular monthly issues in 2013.

The response from the THz community to our first two issues has been overwhelming. We have had unsolicited requests from more than a 1000 members of the science community for copies of the Inaugural and November issues, and have distributed close to 18 000 print issues through regular subscription lists. We have also distributed the Inaugural issue to attendees at several international THz conferences that took place in the last quarter of 2011. My personal thanks, and the appreciation of our entire editorial team, go out to those authors who have taken a chance on supporting the journal through their technical paper contributions at this very early stage.

The journal has now moved entirely to an electronic submission and review process supported through Manuscript Central (direct paper submissions at http://mc.manuscriptcentral.com/ieee-thz or through the links at our website at http://www.thz.ieee.org). We are reaching a very wide community, so please think about submitting to IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY when you want your peers and colleagues to learn about the quality research you are doing, no matter what the core discipline. *If your work involves the development, application or science of THz, please consider this journal as THE primary outlet for impacting our broad-based community*.

As a special treat this month, and to kick off the first full year of our publication, we are highlighting expanded papers from the world's oldest continuing "*THz only*" conference, the *International Symposium on Space Terahertz Technology (ISSTT)*. Papers from the conference appear as a Special Supplement to the January regular issue. The *ISSTT* conference series started in 1990 under the joint sponsorship of the NASA Jet Propulsion Laboratory and the University of Michigan Center for Space Terahertz Technology. It was originally conceived, set up, and directed by notable Michigan Professor of Electrical Engineering, Dr. Fawwaz Ulaby, and JPL's Dr. Margaret Frerking and Dr. Carl Kukkonen. The conference took on a life of its own in 1993, even before the Michigan Center ended in 1995, and has been a well attended yearly event ever since. *ISSTT* has focused exclusively on terahertz sensors, sources, and instruments for its full 21 years, and has consistently produced a high quality digest with extremely detailed papers that are now fully accessible through a server maintained by the National Radio Astronomy Observatory in Charlottesville, VA (http://www.nrao.edu/meetings/isstt/index.shtml). Having participated in many of these focused meetings, starting from the very first, it is a great privilege to introduce this conference to the broader terahertz community by highlighting some of the contributions that have been submitted by attendees at *ISSTT 22* held this past April 2011 in Tucson, AZ. Special Supplement Guest Editors, Dr. Chris Walker and Dr. Chris Groppi, who were hosts of the 2011 conference, have teamed up to solicit and provide the contributions that are contained within this issue. All the papers have been taken through our regular review process. Drs. Walker and Groppi provide a more detailed introduction as the front piece to the Special Supplement.

In addition to our conference supplement, we have a number of regular issue papers covering a wide range of THz topics and representing a broad international base. We lead off with a very nice *invited* paper on operating temperature limitations for THz quantum cascade lasers from some well-known QCL pioneers (*Chassagneux et al.*). This is followed by two invited papers (*Park et al.* and *Kim et al.*) from groups in Korea that are part of the very exciting multi-centered THz-Bio institute, chaired by Professor Gun Sik Park at SNU, Seoul, Korea. They introduce some extremely novel THz medical imaging and tagging techniques that may provide the first opportunities for THz *in vivo* applications. Two papers on THz spectroscopy techniques for liquids (*Saha*) and solids (*Brigada and Zhang*) by groups at University of Glasgow, U.K., and the well-known RPI THz Center in Troy, NY, follow the medical imaging papers. We then include a quite unusual paper on THz birefringence of wood by the UNBC group in British Columbia, Canada (*Todoruk et al.*). This is succeeded by a paper on THz oscillators (*Jagtap and Minot*) from Paris, France, and another on THz photonic crystal waveguide losses (*Degirmenci et al.*) from Dublin City University, Ireland. Finally we conclude with a thorough paper on THz calibration techniques (*Williams*) from the group at NIST, Boulder, CO. All of these papers were submitted before the release of our first regular issue this past November, so again I would like to thank these authors for thinking of this IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY as their publication venue of choice.

This month's THz Pioneer article takes us to Essex, UK to Terahertz research scientist, Dr. Maurice Kimmitt, who has been working in our field for 55+ years. I hope you will enjoy the diversion and come away with something that relates to, or helps you with, your own career in THz.

Finally, let me again thank our very dedicated and hard working editorial team and all the reviewers who have helped us get started, and who continue to volunteer their precious time for the benefit of our field. We are all pledged to provide you with the best our community has to offer. Your comments and criticisms are always welcome (*phs@caltech.edu*), and will be responded to personally by this Editor-in-Chief. Now, we are pleased to offer you Volume 2, Issue 1 of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

Yours sincerely,

Digital Object Identifier 10.1109/TTHZ.2011.2178650

Peter H. Siegel, *Founding Editor-in-Chief*

Peter H. Siegel (S'77–M'83–SM'98–F'01) received the B.A. degree from Colgate University, in 1976, and the Ph.D. degree from Columbia University, in 1983.

He holds appointments as Faculty Associate in Electrical Engineering and Senior Scientist in Biology at Caltech and Senior Research Scientist and Technical Group Supervisor for Submillimeter Wave Advanced Technology (SWAT), Jet Propulsion Laboratory , Pasadena, CA. He has been working in the areas of millimeter and submillimeter-wave technology and applications for 35 years and has PI'd or co-I'd more than 75 R&D programs and been involved in four major space flight instruments. He has published more than 275 articles in the THz field and has given more than 75 invited talks in the U.S. and abroad on this subject. At JPL,he leads a group of 20+ research scientists and engineers developing THz technology for NASA's near and long term space missions as well as for several DoD applications. At Caltech, he is involved in new biological and medical applications of THz. His current interests are split between traditional Earth, planetary and astrophysics applications and new THz applications in medicine and biology.

Among many other duties, Dr. Siegel chairs the International Society for Infrared, Millimeter and Terahertz Waves (IRMMW-THz), the oldest and largest venue devoted to the field of far-IR techniques, science and applications, and he served as conference organizer and chair for IRMMW-THz 2008 in Pasadena. He has served as an IEEE Distinguished Microwave Lecturer, co-chair and chair of MTT Committee 4-THz Technology, a TPC and Speaker's bureau member, and as organizer and chair of seven special sessions at the IEEE International Microwave Symposia. He is extremely pleased, and very excited to be involved in the formation and launching of the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY. (His Web Page: http://www.thz.caltech.edu.)

EXECUTIVE EDITOR

Dylan F. Williams (M'80–SM'90–F'02) received the Ph.D. degree in electrical Engineering from the University of California, Berkeley in 1986. He joined the Electromagnetic Fields Division of the National Institute of Standards and Technology, Boulder, CO, in 1989, where he develops electrical waveform and microwave metrology. He has published over 80 technical papers.

Dr. Williams is the recipient of the Department of Commerce Bronze and Silver Medals, the Astin Measurement Science Award, two Electrical Engineering Laboratory's Outstanding Paper Awards, two Automatic RF Techniques Group (ARFTG) Best Paper Awards, the ARFTG Automated Measurements Technology Award, and the IEEE Morris E. Leeds Award. He also served as Editor of the IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES from 2006 to 2010.

ADMINISTRATIVE EDITOR

Sharri Shaw was born in Michigan, and currently resides in Boulder, CO. She received the B.A. degree in english and a minor in psychology, from Saginaw Valley State University, in 1994. She continued her studies in 2001 in the Master in Education with Initial Certification (M.Ed.) program at Aquinas College, where she received her Secondary Level Teacher Certification.

From 2002 to 2005, she was a teacher in Michigan. From 2006 to 2010, she was the Assistant Editor of the IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES. She currently holds the same position with *IEEE Microwave Magazine*, and also serves as the Publications Administrator for the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

TOPIC EDITORS

Stefano Alberti received the Ph.D. degree from the Swiss Federal Institute of Technology (EPFL), Lausanne, Switzerland, in 1991, with his research dedicated to the study of quasi-optical gyrotrons.

After a two year post-doctorate at MIT, Cambridge, where he worked on CARM's and X-Band relativistic-TWT, he returned in 1993 to the Centre for Plasma Physics Research (CRPP), EPFL. Since then, within the European high-power gyrotron development program, he worked at CRPP developing and testing high-power high-frequency gyrotrons for a variety of EC-system installed on magnetically confined plasma experiments, such as TCV at CRPP, Tore-Supra, W7-X and presently ITER. In parallel to this activity, he contributed to the design, installation and testing of complete electron-cyclotron system from "plug" to plasma for these same experiments. On TCV he actively contributed on performing electron-cyclotron heating and current-drive experiments. Since 2008, he is responsible for the development of frequency-tunable gyrotrons for DNP-enhanced NMR-spectroscopy. He is currently Lecturer at EPFL, where he teaches an introductory course in plasma physics. He is the author or coauthor of over 60 refereed publications.

René Beigang received the Diploma and Ph.D. degrees from the University of Hannover, Hannover, Germany.

He spent 3 years as a post-doctorate and visiting scientist at the IBM T.J. Watson Research Center, Yorktown Heights, NY. He was Associate Professor at the Free University of Berlin and the University of Kaiserslautern. He is now a full professor at the Department of Physics of the University of Kaiserslautern. Since 2005, he is also Head of the Department on Terahertz Measurement and Systems of the Fraunhofer Institute for Physical Measurement Techniques. His current research interests include nonlinear optics, generation and application of THz radiation, THz spectroscopy, applications of THz radiation in science and technology, realization and investigation of THz meta materials. (His homepage: http://www.physik.uni-kl.de/beigang).

A. Giles Davies received the B.Sc. degree in chemical physics from the University of Bristol, Bristol, U.K., in 1987, and the Ph.D. degree in semiconductor physics from the University of Cambridge, Cambridge, U.K., in 1991.

He is currently Professor of Electronic and Photonic Engineering at the University of Leeds, Leeds, U.K. His research interests concentrate on the electrical and optical properties of low- dimensional and nanostructured electronic systems, and multilayered semiconductor devices, with particular recent focus on the development of terahertz frequency systems and the exploitation of biological processes for nanoscale assembly.

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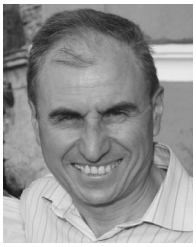

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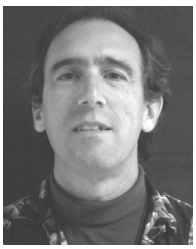

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During 1987–1995, he worked at Naval Research Laboratory, Washington, DC, through Omega-P, Inc. In 1995, he joined Seoul National University and currently is a Professor in the Department of Physics and Astronomy, and also jointly with the Department of Electrical Engineering at Seoul National University. He leads the Center for THz-Bio Application Systems (2009–2018) at Seoul National University supported by the Ministry of Education, Science and Technology of Korea as a Director.

Dr. Parks' service to journal editor includes *Journal of Korean Physical Society* (JKPS), *Journal of New Physics*, and the *THz Science and Technology*. He serves as a topical editor for IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY, and as a technical committee member of IEEE Electron Devices Society in Vacuum Electronics since 1999. He was a conference chair for 4th IEEE International Vacuum Electronics Conference in 2003 held in Korea and is a co-chair for 34th International Conference on Infrared, Millimeter, and Terahertz Waves in 2009 held in Korea. He is the author of over 100 journal publications in the areas of high power microwaves to terahertz waves.

Christopher Walker has over 25 years experience designing, building, and using state-of-the-art receiver systems for THz astronomy. He is a Professor of Astronomy and an Associate Professor of Optical Sciences and Electrical Engineering at the University of Arizona (UofA). He has worked in industry (TRW Aerospace and JPL) as well as academia. As a Millikan Fellow in Physics at Caltech, he worked on the development of low-noise, SIS waveguide receivers above 400 GHz and explored techniques for etching waveguide out of silicon. On joining the UofA faculty in 1991 he began the Steward Observatory Radio Astronomy Lab (SORAL), which has become a world leader in developing THz receiver systems for astronomy and other remote sensing applications. These instruments are multi-institutional efforts, with key components coming from JPL, several universities, and a number of industrial partners. He manages and coordinates these efforts. Instruments developed by Prof. Walker's team have served as primary facility instruments at the Heinrich Hertz Telescope on Mt. Graham, AZ, and the AST/RO telescope at the South Pole. He is leading the effort to design and build the world's largest (64 pixels) submillimeter-wave heterodyne array receiver (SuperCam). He is also PI of the NASA funded long duration balloon project "The Stratospheric THz Observatory (STO)". He has published numerous papers on star formation and protostellar evolution. He has served as dissertation director for nine Ph.D. students.

Editorial

WELCOME to our fourth bimonthly issue of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY. We are very excited to open this month's issue with an interview article on THz Pioneer and Nobel Laureate, Dr. Robert W. Wilson. Dr. Wilson is a pioneer in space THz spectroscopy, having made the first observations of carbon monoxide in the Orion Nebula in 1970. He also shared the Nobel Prize in Physics in 1978 with Arno Penzias, for the discovery and measurement of the Cosmic Microwave Background. I believe you will find the sequence of events and the outside influences that led to these discoveries enlightening.

We are also extremely pleased to highlight this month, an invited paper from Professor S. J. Ben Yoo at the University of California Davis, introducing THz signal processing concepts in mainstream communications circuits. This is a topic that this Editor-in-Chief believes can truly open up applications for our expanding technology.

On the traditional RF side, we have two papers representing advances in THz solid-state components and measurement techniques—a record performance result from a solid-state Schottky diode multiplier chain at 2.5–2.7 THz (*Maestrini et al.*), and wafer probe performance in the 300–500 GHz frequency range (*Fung et al.*).

The increasing encroachment of CMOS circuits into the THz regime is represented by a novel oscillator circuit from a UCLA team (*Gu et al.*) that reaches 870 GHz through harmonic operation.

Plastic slugs are drawn into THz fiber waveguides to make a photonic band gap filter as reported by *Stecher et al.*, in a first of its kind demonstration.

Two papers from the 2011 International Symposium on Space Terahertz Technology that did not make it in time for the January issue appear in March (*Billade et al. and Maier et al.*) to conclude our highlight of that conference.

Modeling papers cover THz traveling-wave tube design (*Gensheimer et al.*), and a useful technique for including etalon effects when imaging multiple dielectric layers (*Kniffin and Zurk*). *A special thanks to Kniffin and Zurk for allowing us to use their contribution as the first test of our all-electronic Scholar One input and review process.*

The use of THz imaging for rust detection on steel plates is introduced by *Fuse et al.*, and our final article of the issue (*Schneider et al.*), discusses wireless links up to 900 GHz.

After a very busy Fall 2011, preparing the first three issues of these transactions, we got a little behind schedule, and as a result our March issue is a bit thinner than anticipated. However we are on course for a very full issue in May, so please keep us on your "*THz radar screen*" at least until then.

Let me reiterate our thanks to our very dedicated and hard working editorial team, and to the great reviewers who have helped us get started. Both groups continue to volunteer their precious time, and we are all pledged to provide you with the very best our community has to offer.

Your comments and criticisms are always welcome, and will be responded to personally by this Editor-in-Chief (phs@caltech.edu).

Now, we are pleased to offer you Volume 2, Issue 1 of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

Yours sincerely,

PETER H. SIEGEL, *Founding Editor-in-Chief*

Peter H. Siegel (S'77–M'83–SM'98–F'01) received the B.A. degree from Colgate University, in 1976, and the Ph.D. degree from Columbia University, in 1983.

He holds appointments as Faculty Associate in Electrical Engineering and Senior Scientist in Biology at Caltech and Senior Research Scientist and Technical Group Supervisor for Submillimeter Wave Advanced Technology (SWAT), Jet Propulsion Laboratory , Pasadena, CA. He has been working in the areas of millimeter and submillimeter-wave technology and applications for 35 years and has PI'd or co-I'd more than 75 R&D programs and been involved in four major space flight instruments. He has published more than 275 articles in the THz field and has given more than 75 invited talks in the U.S. and abroad on this subject. At JPL,he leads a group of 20+ research scientists and engineers developing THz technology for NASA's near and long term space missions as well as for several DoD applications. At Caltech, he is involved in new biological and medical applications of THz. His current interests are split between traditional Earth, planetary and astrophysics applications and new THz applications in medicine and biology.

Among many other duties, Dr. Siegel chairs the International Society for Infrared, Millimeter and Terahertz Waves (IRMMW-THz), the oldest and largest venue devoted to the field of far-IR techniques, science and applications, and he served as conference organizer and chair for IRMMW-THz 2008 in Pasadena. He has served as an IEEE Distinguished Microwave Lecturer, co-chair and chair of MTT Committee 4-THz Technology, a TPC and Speaker's bureau member, and as organizer and chair of seven special sessions at the IEEE International Microwave Symposia. He is extremely pleased, and very excited to be involved in the formation and launching of the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY. (His Web Page: http://www.thz.caltech.edu.)

EXECUTIVE EDITOR

Dylan F. Williams (M'80–SM'90–F'02) received the Ph.D. degree in electrical Engineering from the University of California, Berkeley in 1986. He joined the Electromagnetic Fields Division of the National Institute of Standards and Technology, Boulder, CO, in 1989, where he develops electrical waveform and microwave metrology. He has published over 80 technical papers.

Dr. Williams is the recipient of the Department of Commerce Bronze and Silver Medals, the Astin Measurement Science Award, two Electrical Engineering Laboratory's Outstanding Paper Awards, two Automatic RF Techniques Group (ARFTG) Best Paper Awards, the ARFTG Automated Measurements Technology Award, and the IEEE Morris E. Leeds Award. He also served as Editor of the IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES from 2006 to 2010.

Digital Object Identifier 10.1109/TTHZ.2012.2186714

ADMINISTRATIVE EDITOR

Sharri Shaw was born in Michigan, and currently resides in Boulder, CO. She received the B.A. degree in english and a minor in psychology, from Saginaw Valley State University, in 1994. She continued her studies in 2001 in the Master in Education with Initial Certification (M.Ed.) program at Aquinas College, where she received her Secondary Level Teacher Certification.

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TOPIC EDITORS

René Beigang received the Diploma and Ph.D. degrees from the University of Hannover, Hannover, Germany.

He spent 3 years as a post-doctorate and visiting scientist at the IBM T.J. Watson Research Center, Yorktown Heights, NY. He was Associate Professor at the Free University of Berlin and the University of Kaiserslautern. He is now a full professor at the Department of Physics of the University of Kaiserslautern. Since 2005, he is also Head of the Department on Terahertz Measurement and Systems of the Fraunhofer Institute for Physical Measurement Techniques. His current research interests include nonlinear optics, generation and application of THz radiation, THz spectroscopy, applications of THz radiation in science and technology, realization and investigation of THz meta materials. (His homepage: http://www.physik.uni-kl.de/beigang).

A. Giles Davies received the B.Sc. degree in chemical physics from the University of Bristol, Bristol, U.K., in 1987, and the Ph.D. degree in semiconductor physics from the University of Cambridge, Cambridge, U.K., in 1991.

He is currently Professor of Electronic and Photonic Engineering at the University of Leeds, Leeds, U.K. His research interests concentrate on the electrical and optical properties of low- dimensional and nanostructured electronic systems, and multilayered semiconductor devices, with particular recent focus on the development of terahertz frequency systems and the exploitation of biological processes for nanoscale assembly.

Jack East received the Bachelors' and Ph.D. degrees from The University of Michigan.

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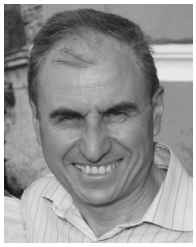
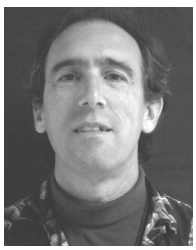
Dr. East is a member of the IEEE P1785 Standards Committee for Rectangular Metallic Waveguides and their interfaces, MTT TCC 4 (Terahertz Technology and Applications) and an area editor for the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.



Gian Piero Gallerano received the Ph.D. degree in physics from the University of Rome, Italy, in 1980, with a thesis on the realization of a tunable color center laser in the near infrared.

In 1981 he was a Visiting Fellow at the Technical University Hannover, Germany. In 1983 he joined the High Power Laser Laboratory , ENEA Research Center, Frascati, Italy, to work on the development of infrared free electron lasers (FEL). In 1991 he was a Visiting Scholar at the Ginzton Laboratory, EE Department, Stanford University, CA. His work on FELs lead to the realization of the ENEA Compact FEL (90–150 GHz) and of the Compact Advanced THz Source, FEL-CATS (0.4–0.7 THz). From 2001 to 2004 he has been the Coordinator of the European project THz-BRIDGE involving ten research institutes in the study the interaction of THz radiation with biological systems. From 2005 to 2007 he has been in charge of the ENEA participation in the European project EUROFEL. He is currently the Head of the Radiation Sources Laboratory at ENEA Frascati. His areas of interest include generation of THz radiation and its application in the biological, biomedical, environmental and art conservation fields, THz imaging techniques, coherent emission from RF modulated electron beams, free electron lasers, optical design and diagnostics in the infrared. He has published over 100 papers in international journals.

Dr. Gallerano has chaired the "35th International Conference on Infrared, Millimeter and THz Waves" IRMMW-THz 2010 held in Rome, Italy, September 5–10, 2010. He has been a member of the Italian Physical Society since 1981 and is currently an associate member of the Bioelectromagnetics Society.



Erich N. Grossman received the A.B. degree in physics from Harvard College, Cambridge, MA, in 1980, and a Ph.D. degree, also in physics, from the California Institute of Technology, Pasadena, in 1987. His thesis work involved development of an ultra-low noise, heterodyne receiver for 2 THz astronomy.

From 1988 to 1989, he was a post-doctoral fellow at the University of Texas at Austin, and in 1989, he joined the National Institute of Standards and Technology, Boulder, CO, where he is now a physicist in the Optoelectronics Division. His work at NIST focuses on infrared and submillimeter system development.

Dr. Grossman's notable accomplishments include the development and demonstration of the world's highest frequency, high efficiency lithographic antennas, the world's highest frequency Josephson junctions, (awarded a Department of Commerce Gold Medal in 1993), and early conception and development of the SQUID multiplexer, first enabling large monolithic arrays of superconducting detectors. More recently, he has developed several 0.1–1 THz cameras for security applications. He is also chair of the Metrology Working Group for the DARPA Terahertz Electronics program.

Peter Uhd Jepsen (M'10) received the M.Sc. degree in physics and chemistry from Odense University, Denmark, in 1994, and the Ph.D. degree in natural sciences from Århus University, Denmark in 1996.

He was at the University of Freiburg, Germany from 1996 to 2004, working with terahertz time-domain spectroscopy. From 2005 he was Associate Professor at the Technical University of Denmark (DTU), and since 2008 Professor and Head of the Terahertz Technologies and Biophotonics group at DTU. In 2008/2009 he was Visiting Professor at Osaka University. His research areas include photonics-based THz technology, broadband THz spectroscopy for chemical sensing, imaging, chemistry, and water dynamics in the THz range, and time-resolved THz spectroscopy of ultrafast phenomena in the THz range.

Kodo Kawase received B.S. degree in electronic engineering from Kyoto University in 1989, and Ph.D degree in electronic engineering from Tohoku University in 1996.

He became an Initiative Researcher at RIKEN in 2001. He became a Professor of Graduate School of Engineering, Nagoya University, Japan, in 2005. He has been conducting research activities in several directions within the THz field. He developed several types of widely tunable THz sources using nonlinear optical effects, and suggested a whole range of real-life applications. He has published more than 130 articles in the THz field and has given more than 160 invited talks on this subject.

Dr. Kawase received the 1997 Young Scientist Award from the JSAP, the 1998 Excellent Presentation Award, the 2000 and 2006 Prize of Laser Engineering from the Laser Society of Japan, the 2002 Marubun research and encouragement award and 2006 Marubun Special Research Award by the Marubun Research Promotion Foundation (MRPF), and the the 2005 Young Scientists' Prize by the Commendation for Science and Technology by the Minister of Education, Culture, Science and Technology (MEXT).

Martin Koch was born in Marburg, Germany in 1963. He received the Diploma and Ph.D. degree form the University of Marburg in 1991 and 1995, respectively.

From 1995 to 1996 he was a post-doctorate at Bell Labs/Lucent Technologies, Holmdel, NJ. From 1996 to 1998 worked in the photonics and optoelectronics group at the University of Munich. From 1998 to 2008 he was associate professor at the Technical University of Braunschweig. In 2003, he did a three-month sabbatical at the University of California in Santa Barbara. Since 2009 he is full professor of physics at the Philipps University Marburg, Germany. His research interests are terahertz systems and their applications, semiconductor disk lasers and ultrafast spectroscopy on semiconductors.

In 2003, Dr. Koch was awarded the Kaiser-Friedrich Research Prize.

Nuria Llombart received the Electrical Engineering degree and Ph.D. degree from the Polytechnic University of Valencia, Spain, in 2002 and 2006 respectively.

During her Master's degree studies she spent one year at the Friedrich-Alexander University of Erlangen-Nuremberg, Germany, and worked at the Fraunhofer Institute for Integrated Circuits, Erlangen, Germany. From 2002 until 2007, she was with the Antenna Group at the TNO Defence, Security and Safety Institute, The Hague, The Netherlands, working as Ph.D. student and afterwards as researcher. From 2007 until 2010, she was a Post-Doctoral Fellow at the California Institute of Technology, working for the Sub millimeter Wave Advance Technology group of the Jet Propulsion Laboratory (JPL), Pasadena, CA. Currently, she holds a "Ramón y Cajal" fellowship at the Optics Department of the Complutense University of Madrid, Spain, while she continues to be an affiliate at JPL, Pasadena. Her research interests include the analysis and design of planar antennas, periodic structures, reflector antennas, lens antennas, waveguide structures, with emphasis in the THz range.

Dr. Llombart was co-recipient of the H. A. Wheeler Award for the Best Applications Paper of 2008 in the IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION. She was also a co-recipient of an Honorable Mention at the 2010 European Conference of Antennas. She serves as Topical Editor for the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

Imran Mehdi (F'10) received the B.S.E.E. degree in 1985, the M.S.E.E. degree in 1986, and the Ph.D . degree in 1990, all from the University of Michigan.

He is currently Principal Member of Engineering staff at the Jet Propulsion Laboratory, California Institute of Technology, Pasadena. His responsibilities include developing THz components and subsystems for current and future NASA missions. He joined JPL in 1990 where his first task included the design and fabrication of low-parasitic planar Schottky diodes for submillimeter-wave applications. These devices were implemented on the ozone monitoring Microwave Limb Sounder instrument which is still operational, as well as the MIRO instrument which represents the first submillimeter-wave receiver that will rendezvous with a comet in 2014. From 1999, he led the effort of developing broadband solid-state sources from 200 to 2500 GHz for the Heterodyne Instrument for Far Infrared (HIFI) on the Herschel Space Observatory, a cornerstone European Space Agency mission currently in space. This effort led to realization of wide-band solid-state sources in the THz range enabling ground-breaking astrophysics observations in space as well as at many ground-based observatories. His current interests include both mm and sub-mm wave devices, semiconductor fabrication technology, high-frequency instrumentation, and heterodyne receivers for miniature systems.

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Jan Stake (M'95) received the M.Sc. degree in electrical engineering and Ph.D. degree in microwave electronics from Chalmers University of Technology, Göteborg, Sweden, in 1994 and 1999, respectively.

In 1997, he was a Research Assistant at the University of Virginia, Charlottesville. From 1999 to 2001, he was a Research Fellow in the millimeter wave group at the Rutherford Appleton Laboratory, U.K. He then joined Saab Combitech Systems AB as a Senior RF/microwave Engineer until 2003. From 2000 to 2006, he held different academic positions

at Chalmers and was also Head of the Nanofabrication Laboratory at MC2 between 2003 and 2006. During 2007, he was a Visiting Professor in the Submillimeter Wave Advanced Technology (SWAT) group at Caltech/JPL, exploring THz applications in biology and medicine. He is currently Professor and Head of the Terahertz and Millimetre Wave Laboratory, Chalmers. His research involves terahertz sources, detectors and mixers, high frequency semiconductor devices, graphene electronics, terahertz measurement techniques and applications.

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Editorial

WITH THIS, our fifth release of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY, we are very pleased to be back on track with a full and *broad spectrum* issue. Although we have no invited papers this month, there are 13 strong articles covering new THz sources, room temperature and superconducting detectors, device thermal modeling, guided wave structures, frequency selective surfaces, microbolometer arrays, quantum cascade laser and surface plasmon polariton device designs, and atmospheric transmission of THz waves, and an interesting new THz imaging algorithm based on the Born approximation.

Our lead off article by the inventors of the new THz VECSEL (*vertical external cavity surface emitting laser*) source is especially exciting. If you are new to the THz community, I am very sure you will take away some interesting nuggets from our THz Pioneer article on analytical chemist, THz spectroscopist, and academic sage, Professor Richard Saykally.

In our next issue (*July*) we will have a wonderful review article from JPL and Caltech astronomers, Dr. Paul Goldsmith and Professor Dariusz Lis, on the most recent THz related findings from the European Space Agency's Herschel Space Telescope mission. We will also carry an article on noted THz photonics pioneer, Professor Dan Grischkowsky.

As usual, I want to strongly encourage those of you who wish to keep this journal a centerpiece in the service of our THz community, to please help us establish a strong technical following by contributing your original research and applications to us through our Manuscript Central process at http://www.thz.ieee.org. We cannot prosper without your continued interest and support.

Let me again thank our tireless editorial team, and especially our tried and true, and slowly expanding group of review board members. Please write to me or any member of our Editorial Board if you can spare some time, and are willing to volunteer your technical or scientific expertise to help us keep on track with our goal of having a consistently rapid review process. We have pledged to provide you with the very best *we* can offer, but we need *your* very best as well, if we are to continue to improve. Your comments and criticisms are always welcome, and will be responded to personally by this Editor-in-Chief (*phs@caltech.edu*).

Now, we are pleased to offer you Volume 2, Issue 3, of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

Yours sincerely,

PETER H. SIEGEL, *Founding Editor-in-Chief*

Digital Object Identifier 10.1109/TTHZ.2012.2196069

Peter H. Siegel (S'77–M'83–SM'98–F'01) received the B.A. degree from Colgate University, in 1976, and the Ph.D. degree from Columbia University, in 1983.

He holds appointments as Faculty Associate in Electrical Engineering and Senior Scientist in Biology at Caltech and Senior Research Scientist and Technical Group Supervisor for Submillimeter Wave Advanced Technology (SWAT), Jet Propulsion Laboratory, Pasadena, CA. He has been working in the areas of millimeter and submillimeter-wave technology and applications for 35 years and has PI'd or co-I'd more than 75 R&D programs and been involved in four major space flight instruments. He has published more than 275 articles in the THz field and has given more than 75 invited talks in the U.S. and abroad on this subject. At JPL,he leads a group of 20+ research scientists and engineers developing THz technology for NASA's near and long term space missions as well as for several DoD applications. At Caltech, he is involved in new biological and medical applications of THz. His current interests are split between traditional Earth, planetary and astrophysics applications and new THz applications in medicine and biology.

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René Beigang received the Diploma and Ph.D. degrees from the University of Hannover, Hannover, Germany.

He spent 3 years as a post-doctorate and visiting scientist at the IBM T. J. Watson Research Center, Yorktown Heights, NY. He was Associate Professor at the Free University of Berlin and the University of Kaiserslautern. He is now a full professor at the Department of Physics of the University of Kaiserslautern. Since 2005, he is also Head of the Department on Terahertz Measurement and Systems of the Fraunhofer Institute for Physical Measurement Techniques. His current research interests include nonlinear optics, generation and application of THz radiation, THz spectroscopy, applications of THz radiation in science and technology, realization and investigation of THz meta materials. (His homepage: http://www.physik.uni-kl.de/beigang).

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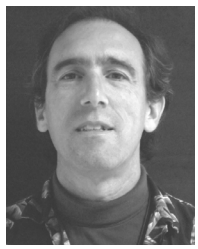

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In 1997, he was a Research Assistant at the University of Virginia, Charlottesville. From 1999 to 2001, he was a Research Fellow in the millimeter wave group at the Rutherford Appleton Laboratory, U.K. He then joined Saab Combitech Systems AB as a Senior RF/microwave Engineer until 2003. From 2000 to 2006, he held different academic positions at Chalmers and was also Head of the Nanofabrication Laboratory at MC2 between 2003 and 2006. During 2007, he was a Visiting Professor in the Submillimeter Wave Advanced Technology (SWAT) group at Caltech/JPL, exploring THz applications in biology and medicine. He is currently Professor and Head of the Terahertz and Millimetre Wave Laboratory, Chalmers. His research involves terahertz sources, detectors and mixers, high frequency semiconductor devices, graphene electronics, terahertz measurement techniques and applications.

Christopher Walker has over 25 years experience designing, building, and using state-of-the-art receiver systems for THz astronomy. He is a Professor of Astronomy and an Associate Professor of Optical Sciences and Electrical Engineering at the University of Arizona (UofA). He has worked in industry (TRW Aerospace and JPL) as well as academia. As a Millikan Fellow in Physics at Caltech, he worked on the development of low-noise, SIS waveguide receivers above 400 GHz and explored techniques for etching waveguide out of silicon. On joining the UofA faculty in 1991 he began the Steward Observatory Radio Astronomy Lab (SORAL), which has become a world leader in developing THz receiver systems for astronomy and other remote sensing applications. These instruments are multi-institutional efforts, with key components coming from JPL, several universities, and a number of industrial partners. He manages and coordinates these efforts. Instruments developed by Prof. Walker's team have served as primary facility instruments at the Heinrich Hertz Telescope on Mt. Graham, AZ, and the AST/RO telescope at the South Pole. He is leading the effort to design and build the world's largest (64 pixels) submillimeter-wave heterodyne array receiver (SuperCam). He is also PI of the NASA funded long duration balloon project "The Stratospheric THz Observatory (STO)". He has published numerous papers on star formation and protostellar evolution. He has served as dissertation director for nine Ph.D. students.

Editorial

WELCOME to our sixth issue of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY! This July 2012 release marks the culmination of one full year of our new journal. We are very excited to mark this small anniversary with a feature article from astronomers, Dr. Paul Goldsmith of the NASA Jet Propulsion Laboratory, and Professor Dariusz Lis of the California Institute of Technology. They have kindly consented to review the latest THz results from the HIFI instrument, *Heterodyne Instrument for the Far Infrared*, launched as part of the European Space Agency's *Herschel Space Observatory* in May 2009.

Both HIFI, and its companion instruments on Herschel, have returned enough data on inter-galactic and extra galactic objects to keep cosmologists and astrochemists busy for many decades to come. As you likely already know, the THz field owes much of its early applications to the space science community. The Herschel Space Observatory is, both in technical scope and innovation, the apex of much of the development in this branch of infrared astronomy, which has been ongoing since the early 1970's.[1] HIFI has not disappointed anyone in the astronomy community, and in fact its recent measurements of the deuterium/hydrogen ratio on comet Hartley 2, which point to an abundance of water ice with a very similar chemical signature to the Earth's oceans, is having a dramatic impact on the way all of us look at life's origins.[2] Along with the HIFI article we include two contributions on astronomical receiver technology from well respected THz groups in Germany and Russia (Mayorga *et al.* and Shurakov *et al.*).

In this month's THz Pioneer series, we recognize Oklahoma State Professor Dr. Daniel Grischkowsky, as both a contributor to our historic development, and a regular contributor to our journal. His article, with co-authors Y. Yang and M. Mandehgar, focuses on THz communications with a series of measurements and an accompanying analysis of THz pulse propagation in the atmosphere.

Following the Grischkowsky article is a very creative design paper by noted antenna experts, Llombart-Juan and Neto, addressed at solving the broadband dispersion problem associated with radiators and detectors in pulsed time domain systems.

We also bring you two articles on new radar techniques from well-known teams in Germany, Gente *et al.* and Moll *et al.*, and three articles on resonator structures, all from established THz researchers: frequency selective surfaces by Vegesna *et al.*; a high-Q resonator for conductor and low loss dielectric measurements by Yang *et al.*; and a new type of Mach-Zehnder interferometer based on spoofed surface plasmon polariton waveguide by Xu and Mazumder.

In closing this month's introductory remarks, I would like to ask each of you who is scanning this issue, and who wishes to support our unique and vibrant community of THz engineers and scientists, to send us at least one of yours, or your group's, high quality technical contributions each year. This will go a long way toward helping us establish a continuing publication that can serve as an information nexus for our entire field. Our all-volunteer editorial team is committed to a fair, rigorous, and rapid submission and review process. Throughout our entire first year, we have strived to live up to our pledge to publish quality work that cuts across disciplinary lines. We still need many more contributions from outside the RF and optoelectronics communities if we are to continue to realize our goal of serving all THz researchers and THz applications. Please do not hesitate to write to me *(phs@caltech.edu)*, or any of our Topic Editors, if you want to contribute a manuscript, volunteer, ask questions, or simply to give us some suggestions or feedback—positive or negative—that will help us serve you better.

Now, we are pleased to offer you Volume 2, Issue 4, the sixth issue of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

Yours sincerely,

PETER H. SIEGEL, *Editor-in-Chief*

Peter H. Siegel (S'77–M'83–SM'98–F'01) received the B.A. degree from Colgate University, Hamilton, NY, in 1976, and the Ph.D. degree from Columbia University, New York, in 1983.

He holds appointments as Faculty Associate in Electrical Engineering and Senior Scientist in Biology at Caltech and Senior Research Scientist at the Jet Propulsion Laboratory (JPL) in Pasadena, CA. He has been working in the areas of millimeter and submillimeter-wave technology and applications for 35 years and has PI'd or co-I'd more than 75 R&D programs and been involved in four major space flight instruments. He has published more than 275 articles in the THz field and has given more than 100 invited talks in the US and abroad on this subject. At JPL, he founded, and led for more than 20 years, the JPL Submillimeter Wave Advanced Technology (SWAT) team, a group of 20+ research scientists and engineers developing THz technology for NASA's near and long term space missions as well as for several DoD applications. At Caltech, Dr. Siegel is involved in new biological and medical applications of THz. His current interests are split between traditional Earth, planetary and astrophysics applications and new THz applications in medicine and biology.

Among many other duties, Dr. Siegel co-chaired and chaired for six years, and is now General Secretary for the International Conference for Infrared, Millimeter and Terahertz Waves (IRMMW-THz), the oldest and largest venue devoted to the field of far IR techniques, science and applications, and he served as conference organizer and chair for IRMMW-THz 2008 in Pasadena. He also set up and administers the International Society of Infrared, Millimeter and Terahertz Waves in 2010, a non-profit organization that is responsible for overseeing the conference series. He has served as an IEEE Distinguished Microwave Lecturer, co-chair and chair of MTT Committee 4-THz Technology, a TPC and Speaker's bureau member, and as organizer and chair of seven sequential special sessions at the IEEE International Microwave Symposia. He is extremely pleased, and very excited to be involved in the formation and launching of the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY. (His Web Pages: http://www.thz.caltech.edu; http://www.irmmw-thz.org; http://www.thz.ieee.org, e-mail: phs@caltech.edu).

Digital Object Identifier 10.1109/TTHZ.2012.2204350

[1]For a short review of space activities in the THz field, see, for example, P. H. Siegel, "THz instruments for space," *IEEE Transactions on Antennas and Propagation*, vol. 55, no. 11, pp. 2957–2965, Nov. 2007.

[2]"A delivery from space that made a big splash," New York Times, Oct. 10, 2011, http://www.nytimes.com/2011/10/11/science/11comet.html

EXECUTIVE EDITOR

Dylan F. Williams (M'80–SM'90–F'02) received the Ph.D. degree in electrical Engineering from the University of California, Berkeley in 1986. He joined the Electromagnetic Fields Division of the National Institute of Standards and Technology, Boulder, CO, in 1989, where he develops electrical waveform and microwave metrology. He has published over 80 technical papers.

Dr. Williams is the recipient of the Department of Commerce Bronze and Silver Medals, the Astin Measurement Science Award, two Electrical Engineering Laboratory's Outstanding Paper Awards, two Automatic RF Techniques Group (ARFTG) Best Paper Awards, the ARFTG Automated Measurements Technology Award, and the IEEE Morris E. Leeds Award. He also served as Editor of the IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES from 2006 to 2010.

ADMINISTRATIVE EDITOR

Sharri Shaw was born in Michigan, and currently resides in Boulder, CO. She received the B.A. degree in english and a minor in psychology, from Saginaw Valley State University, in 1994. She continued her studies in 2001 in the Master in Education with Initial Certification (M.Ed.) program at Aquinas College, where she received her Secondary Level Teacher Certification.

From 2002 to 2005, she was a teacher in Michigan. From 2006 to 2010, she was the Assistant Editor of the IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES. She currently holds the same position with *IEEE Microwave Magazine*, and also serves as the Publications Administrator for the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

TOPIC EDITORS

Stefano Alberti received the Ph.D. degree from the Swiss Federal Institute of Technology (EPFL), Lausanne, Switzerland, in 1991, with his research dedicated to the study of quasi-optical gyrotrons.

After a two-year post-doctorate at MIT, Cambridge, where he worked on CARMs and X-Band relativistic-TWT, he returned in 1993 to the Centre for Plasma Physics Research (CRPP), EPFL. Since then, within the European high-power gyrotron development program, he worked at CRPP developing and testing high-power high-frequency gyrotrons for a variety of EC-system installed on magnetically confined plasma experiments, such as TCV at CRPP, Tore-Supra, W7-X and presently ITER. In parallel to this activity, he contributed to the design, installation and testing of complete electron-cyclotron system from plug to plasma for these same experiments. On TCV he actively contributed on performing electron-cyclotron heating and current-drive experiments. Since 2008, he is responsible for the development of frequency-tunable gyrotrons for DNP-enhanced NMR-spectroscopy. He is currently Lecturer at EPFL, where he teaches an introductory course in plasma physics. He is the author or coauthor of over 60 refereed publications.

A. Giles Davies received the B.Sc. degree in chemical physics from the University of Bristol, Bristol, U.K., in 1987, and the Ph.D. degree in semiconductor physics from the University of Cambridge, Cambridge, U.K., in 1991.

He is currently Professor of Electronic and Photonic Engineering at the University of Leeds, Leeds, U.K. His research interests concentrate on the electrical and optical properties of low- dimensional and nanostructured electronic systems, and multilayered semiconductor devices, with particular recent focus on the development of terahertz frequency systems and the exploitation of biological processes for nanoscale assembly.

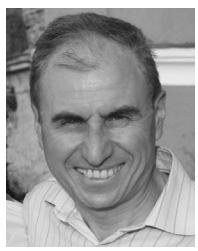
Jack East received the Bachelors' and Ph.D. degrees from The University of Michigan.

He is currently with the Electrical Engineering and Computer Science Department, The University of Michigan, where he conducts research in the areas of high-speed microwave device design and fabrication, circuit modeling and characterization and THz devices.

Dr. East is a member of the IEEE P1785 Standards Committee for Rectangular Metallic Waveguides and their interfaces, MTT TCC 4 (Terahertz Technology and Applications) and an area editor for the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

René Beigang received the Diploma and Ph.D. degrees from the University of Hannover, Hannover, Germany.

He spent 3 years as a post-doctorate and visiting scientist at the IBM T.J. Watson Research Center, Yorktown Heights, NY. He was Associate Professor at the Free University of Berlin and the University of Kaiserslautern. He is now a full professor at the Department of Physics of the University of Kaiserslautern. Since 2005, he is also Head of the Department on Terahertz Measurement and Systems of the Fraunhofer Institute for Physical Measurement Techniques. His current research interests include nonlinear optics, generation and application of THz radiation, THz spectroscopy, applications of THz radiation in science and technology, realization and investigation of THz meta materials. (His homepage: http://www.physik.uni-kl.de/beigang).



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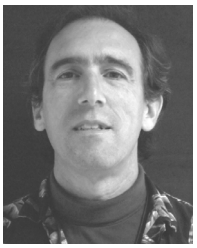

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Dr. Parks' service to journal editor includes *Journal of Korean Physical Society* (JKPS), *Journal of New Physics*, and the *THz Science and Technology*. He serves as a topical editor for IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY, and as a technical committee member of IEEE Electron Devices Society in Vacuum Electronics since 1999. He was a conference chair for 4th IEEE International Vacuum Electronics Conference in 2003 held in Korea and is a co-chair for 34th International Conference on Infrared, Millimeter, and Terahertz Waves in 2009 held in Korea. He is the author of over 100 journal publications in the areas of high power microwaves to terahertz waves.

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In 1997, he was a Research Assistant at the University of Virginia, Charlottesville. From 1999 to 2001, he was a Research Fellow in the millimeter wave group at the Rutherford Appleton Laboratory, U.K. He then joined Saab Combitech Systems AB as a Senior RF/microwave Engineer until 2003. From 2000 to 2006, he held different academic positions at Chalmers and was also Head of the Nanofabrication Laboratory at MC2 between 2003 and 2006. During 2007, he was a Visiting Professor in the Submillimeter Wave Advanced Technology (SWAT) group at Caltech/JPL, exploring THz applications in biology and medicine. He is currently Professor and Head of the Terahertz and Millimetre Wave Laboratory, Chalmers. His research involves terahertz sources, detectors and mixers, high frequency semiconductor devices, graphene electronics, terahertz measurement techniques and applications.

Christopher Walker has over 25 years experience designing, building, and using state-of-the-art receiver systems for THz astronomy. He is a Professor of Astronomy and an Associate Professor of Optical Sciences and Electrical Engineering at the University of Arizona (UofA). He has worked in industry (TRW Aerospace and JPL) as well as academia. As a Millikan Fellow in Physics at Caltech, he worked on the development of low-noise, SIS waveguide receivers above 400 GHz and explored techniques for etching waveguide out of silicon. On joining the UofA faculty in 1991 he began the Steward Observatory Radio Astronomy Lab (SORAL), which has become a world leader in developing THz receiver systems for astronomy and other remote sensing applications. These instruments are multi-institutional efforts, with key components coming from JPL, several universities, and a number of industrial partners. He manages and coordinates these efforts. Instruments developed by Prof. Walker's team have served as primary facility instruments at the Heinrich Hertz Telescope on Mt. Graham, AZ, and the AST/RO telescope at the South Pole. He is leading the effort to design and build the world's largest (64 pixels) submillimeter-wave heterodyne array receiver (SuperCam). He is also PI of the NASA funded long duration balloon project "The Stratospheric THz Observatory (STO)". He has published numerous papers on star formation and protostellar evolution. He has served as dissertation director for nine Ph.D. students.

Editorial

WITH THIS, our seventh issue of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY we continue with our second year of print releases. We include in this issue an interview with pioneering astrophysicist Dr. Thomas G. Phillips, who has devoted his long career to serving the THz community through his development of low-noise receiver technology, and his mountain top, aircraft, and space borne instruments and observations. Professor Phillips is without question, one of the most influential and successful incubators of submillimeter-wave instruments and observation platforms—from the Caltech Submillimeter Observatory and the U.K./Canada/Netherlands James Clerk Maxwell telescope on the top of Mauna Kea, HI, to the high altitude aircraft platforms on the NASA Kuiper Airborne Observatory and the NASA/DLR Stratospheric Observatory for Infrared Astronomy (SOFIA), to the ESA Herschel Space Observatory, now in L2 orbit. Anyone who has set his sights on accomplishing big goals in experimental science will appreciate the patience, dedication, and dramatic twists and turns that accompany such a course, especially in these days of shrinking budgets and falling proposal success rates.

As part of our regular manuscript contributions this month, we think you will enjoy the three lead off articles on terahertz imaging. *Isogawa et al.* describe and demonstrate a new technique in the THz bands for imaging with broadband noise sources realizing three-dimensional reconstructions in an approach similar to that used for optical coherence tomography. *Tsai et al.* present an image enhancement algorithm for improving contrast in the THz bands. *Chen et al.* describe a THz backward wave tube, direct detection imager that is aided by an image processing technique that also improves on the available contrast.

A very practical, and useful article by *Episkopou et al.* compares the accuracies, and pitfalls, of several widely employed numeric modeling tools including HFSS, CST Microwave Studio, EMPro and RSoft. Judging by the ever increasing number of THz researchers that rely heavily on these electromagnetic solvers, this paper is certain to grab some serious attention.

With growing interest in millimeter and perhaps even submillimeter-wave communications, *Priebe et al.* take a look at interference issues in atmospheric propagation at 300 GHz.

Vendik et al. review some progress and developments on THz metamaterials, for those of you who cannot get enough of this topic and *Brandstetter et al.* describe a new superconducting waveguide cavity for use in quantum cascade lasers.

In a paper by *Scherger et al.*, the authors describe and verify the performance of a cost effective THz blaze grating that should find application in both imaging and spectroscopic instruments.

Finally, *Mateos and Gonzalez* present a paper on collective resonance phenomena in InGaAs HEMTs.

As always, I speak for our *entire* Editorial board, when I state that we are committed to serving the *entire* THz community, with the highest quality publication we are able to produce. This quality depends largely on you, the community, and your willingness to contribute the best you have to offer for the further development of terahertz science and techniques. Our email and phone lines are always open to you if you have suggestions, criticisms, concerns or praise for any or all of our very hard working and dedicated volunteers. Please do not hesitate to write to me *(phs@caltech.edu)*, or any of our Topic or Administrative Editors whenever the urge arises. Now, turn the page to start reading Volume 2, Issue 5, of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

Yours sincerely,

PETER H. SIEGEL, *Editor-in-Chief*

Peter H. Siegel (S'77–M'83–SM'98–F'01) received the B.A. degree from Colgate University, Hamilton, NY, in 1976, and the Ph.D. degree from Columbia University, New York, in 1983.

He holds appointments as Faculty Associate in Electrical Engineering and Senior Scientist in Biology at Caltech and Senior Research Scientist at the Jet Propulsion Laboratory (JPL) in Pasadena, CA. He has been working in the areas of millimeter and submillimeter-wave technology and applications for 35 years and has PI'd or co-I'd more than 75 R&D programs and been involved in four major space flight instruments. He has published more than 275 articles in the THz field and has given more than 100 invited talks in the US and abroad on this subject. At JPL, he founded, and led for more than 20 years, the JPL Submillimeter Wave Advanced Technology (SWAT) team, a group of 20+ research scientists and engineers developing THz technology for NASA's near and long term space missions as well as for several DoD applications. At Caltech, Dr. Siegel is involved in new biological and medical applications of THz. His current interests are split between traditional Earth, planetary and astrophysics applications and new THz applications in medicine and biology.

Among many other duties, Dr. Siegel co-chaired and chaired for six years, and is now General Secretary for the International Conference for Infrared, Millimeter and Terahertz Waves (IRMMW-THz), the oldest and largest venue devoted to the field of far IR techniques, science and applications, and he served as conference organizer and chair for IRMMW-THz 2008 in Pasadena. He also set up and administers the International Society of Infrared, Millimeter and Terahertz Waves in 2010, a non-profit organization that is responsible for overseeing the conference series. He has served as an IEEE Distinguished Microwave Lecturer, co-chair and chair of MTT Committee 4-THz Technology, a TPC and Speaker's bureau member, and as organizer and chair of seven sequential special sessions at the IEEE International Microwave Symposia. He is extremely pleased, and very excited to be involved in the formation and launching of the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY. (His Web Pages: http://www.thz.caltech.edu; http://www.irmmw-thz.org; http://www.thz.ieee.org, e-mail: phs@caltech.edu).

Digital Object Identifier 10.1109/TTHZ.2012.2212294

EXECUTIVE EDITOR

Dylan F. Williams (M'80–SM'90–F'02) received the Ph.D. degree in electrical Engineering from the University of California, Berkeley in 1986. He joined the Electromagnetic Fields Division of the National Institute of Standards and Technology, Boulder, CO, in 1989, where he develops electrical waveform and microwave metrology. He has published over 80 technical papers.

Dr. Williams is the recipient of the Department of Commerce Bronze and Silver Medals, the Astin Measurement Science Award, two Electrical Engineering Laboratory's Outstanding Paper Awards, two Automatic RF Techniques Group (ARFTG) Best Paper Awards, the ARFTG Automated Measurements Technology Award, and the IEEE Morris E. Leeds Award. He also served as Editor of the IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES from 2006 to 2010.

ADMINISTRATIVE EDITOR

Sharri Shaw was born in Michigan, and currently resides in Boulder, CO. She received the B.A. degree in english and a minor in psychology, from Saginaw Valley State University, in 1994. She continued her studies in 2001 in the Master in Education with Initial Certification (M.Ed.) program at Aquinas College, where she received her Secondary Level Teacher Certification.

From 2002 to 2005, she was a teacher in Michigan. From 2006 to 2010, she was the Assistant Editor of the IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES. She currently holds the same position with *IEEE Microwave Magazine*, and also serves as the Publications Administrator for the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

TOPIC EDITORS

Stefano Alberti received the Ph.D. degree from the Swiss Federal Institute of Technology (EPFL), Lausanne, Switzerland, in 1991, with his research dedicated to the study of quasi-optical gyrotrons.

After a two-year post-doctorate at MIT, Cambridge, where he worked on CARMs and X-Band relativistic-TWT, he returned in 1993 to the Centre for Plasma Physics Research (CRPP), EPFL. Since then, within the European high-power gyrotron development program, he worked at CRPP developing and testing high-power high-frequency gyrotrons for a variety of EC-system installed on magnetically confined plasma experiments, such as TCV at CRPP, Tore-Supra, W7-X and presently ITER. In parallel to this activity, he contributed to the design, installation and testing of complete electron-cyclotron system from plug to plasma for these same experiments. On TCV he actively contributed on performing electron-cyclotron heating and current-drive experiments. Since 2008, he is responsible for the development of frequency-tunable gyrotrons for DNP-enhanced NMR-spectroscopy. He is currently Lecturer at EPFL, where he teaches an introductory course in plasma physics. He is the author or coauthor of over 60 refereed publications.

A. Giles Davies received the B.Sc. degree in chemical physics from the University of Bristol, Bristol, U.K., in 1987, and the Ph.D. degree in semiconductor physics from the University of Cambridge, Cambridge, U.K., in 1991.

He is currently Professor of Electronic and Photonic Engineering at the University of Leeds, Leeds, U.K. His research interests concentrate on the electrical and optical properties of low- dimensional and nanostructured electronic systems, and multilayered semiconductor devices, with particular recent focus on the development of terahertz frequency systems and the exploitation of biological processes for nanoscale assembly.

Jack East received the Bachelors' and Ph.D. degrees from The University of Michigan.

He is currently with the Electrical Engineering and Computer Science Department, The University of Michigan, where he conducts research in the areas of high-speed microwave device design and fabrication, circuit modeling and characterization and THz devices.

Dr. East is a member of the IEEE P1785 Standards Committee for Rectangular Metallic Waveguides and their interfaces, MTT TCC 4 (Terahertz Technology and Applications) and an area editor for the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

René Beigang received the Diploma and Ph.D. degrees from the University of Hannover, Hannover, Germany.

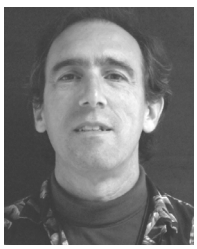
He spent 3 years as a post-doctorate and visiting scientist at the IBM T.J. Watson Research Center, Yorktown Heights, NY. He was Associate Professor at the Free University of Berlin and the University of Kaiserslautern. He is now a full professor at the Department of Physics of the University of Kaiserslautern. Since 2005, he is also Head of the Department on Terahertz Measurement and Systems of the Fraunhofer Institute for Physical Measurement Techniques. His current research interests include nonlinear optics, generation and application of THz radiation, THz spectroscopy, applications of THz radiation in science and technology, realization and investigation of THz meta materials. (His homepage: http://www.physik.uni-kl.de/beigang).

Gian Piero Gallerano received the Ph.D. degree in physics from the University of Rome, Italy, in 1980, with a thesis on the realization of a tunable color center laser in the near infrared.

In 1981 he was a Visiting Fellow at the Technical University Hannover, Germany. In 1983 he joined the High Power Laser Laboratory , ENEA Research Center, Frascati, Italy, to work on the development of infrared free electron lasers (FEL). In 1991 he was a Visiting Scholar at the Ginzton Laboratory, EE Department, Stanford University, CA. His work on FELs lead to the realization of the ENEA Compact FEL (90–150 GHz) and of the Compact Advanced THz Source, FEL-CATS (0.4–0.7 THz). From 2001 to 2004 he has been the Coordinator of the European project THz-BRIDGE involving ten research institutes in the study the interaction of THz radiation with biological systems. From 2005 to 2007 he has been in charge of the ENEA

participation in the European project EUROFEL. He is currently the Head of the Radiation Sources Laboratory at ENEA Frascati. His areas of interest include generation of THz radiation and its application in the biological, biomedical, environmental and art conservation fields, THz imaging techniques, coherent emission from RF modulated electron beams, free electron lasers, optical design and diagnostics in the infrared. He has published over 100 papers in international journals.

Dr. Gallerano has chaired the "35th International Conference on Infrared, Millimeter and THz Waves" IRMMW-THz 2010 held in Rome, Italy, September 5–10, 2010. He has been a member of the Italian Physical Society since 1981 and is currently an associate member of the Bioelectromagnetics Society.



Erich N. Grossman received the A.B. degree in physics from Harvard College, Cambridge, MA, in 1980, and a Ph.D. degree, also in physics, from the California Institute of Technology, Pasadena, in 1987. His thesis work involved development of an ultra-low noise, heterodyne receiver for 2 THz astronomy.

From 1988 to 1989, he was a post-doctoral fellow at the University of Texas at Austin, and in 1989, he joined the National Institute of Standards and Technology, Boulder, CO, where he is now a physicist in the Optoelectronics Division. His work at NIST focuses on infrared and submillimeter system development.

Dr. Grossman's notable accomplishments include the development and demonstration of the world's highest frequency, high efficiency lithographic antennas, the world's highest frequency Josephson junctions, (awarded a Department of Commerce Gold Medal in 1993), and early conception and development of the SQUID multiplexer, first enabling large monolithic arrays of superconducting detectors. More recently, he has developed several 0.1–1 THz cameras for security applications. He is also chair of the Metrology Working Group for the DARPA Terahertz Electronics program.

Peter Uhd Jepsen (M'10) received the M.Sc. degree in physics and chemistry from Odense University, Denmark, in 1994, and the Ph.D. degree in natural sciences from Århus University, Denmark in 1996.

He was at the University of Freiburg, Germany from 1996 to 2004, working with terahertz time-domain spectroscopy. From 2005 he was Associate Professor at the Technical University of Denmark (DTU), and since 2008 Professor and Head of the Terahertz Technologies and Biophotonics group at DTU. In 2008/2009 he was Visiting Professor at Osaka University. His research areas include photonics-based THz technology, broadband THz spectroscopy for chemical sensing, imaging, chemistry, and water dynamics in the THz range, and time-resolved THz spectroscopy of ultrafast phenomena in the THz range.

Kodo Kawase received B.S. degree in electronic engineering from Kyoto University in 1989, and Ph.D degree in electronic engineering from Tohoku University in 1996.

He became an Initiative Researcher at RIKEN in 2001. He became a Professor of Graduate School of Engineering, Nagoya University, Japan, in 2005. He has been conducting research activities in several directions within the THz field. He developed several types of widely tunable THz sources using nonlinear optical effects, and suggested a whole range of real-life applications. He has published more than 130 articles in the THz field and has given more than 160 invited talks on this subject.

Dr. Kawase received the 1997 Young Scientist Award from the JSAP, the 1998 Excellent Presentation Award, the 2000 and 2006 Prize of Laser Engineering from the Laser Society of Japan, the 2002 Marubun research and encouragement award and 2006 Marubun Special Research Award by the Marubun Research Promotion Foundation (MRPF), and the the 2005 Young Scientists' Prize by the Commendation for Science and Technology by the Minister of Education, Culture, Science and Technology (MEXT).

Martin Koch was born in Marburg, Germany in 1963. He received the Diploma and Ph.D. degree form the University of Marburg in 1991 and 1995, respectively.

From 1995 to 1996 he was a post-doctorate at Bell Labs/Lucent Technologies, Holmdel, NJ. From 1996 to 1998 worked in the photonics and optoelectronics group at the University of Munich. From 1998 to 2008 he was associate professor at the Technical University of Braunschweig. In 2003, he did a three-month sabbatical at the University of California in Santa Barbara. Since 2009 he is full professor of physics at the Philipps University Marburg, Germany. His research interests are terahertz systems and their applications, semiconductor disk lasers and ultrafast spectroscopy on semiconductors.

In 2003, Dr. Koch was awarded the Kaiser-Friedrich Research Prize.

Nuria Llombart received the Electrical Engineering degree and Ph.D. degree from the Polytechnic University of Valencia, Spain, in 2002 and 2006 respectively.

During her Master's degree studies she spent one year at the Friedrich-Alexander University of Erlangen-Nuremberg, Germany, and worked at the Fraunhofer Institute for Integrated Circuits, Erlangen, Germany. From 2002 until 2007, she was with the Antenna Group at the TNO Defence, Security and Safety Institute, The Hague, The Netherlands, working as Ph.D. student and afterwards as researcher. From 2007 until 2010, she was a Post-Doctoral Fellow at the California Institute of Technology, working for the Sub millimeter Wave Advance Technology group of the Jet Propulsion Laboratory (JPL), Pasadena, CA. Currently, she holds a "Ramón y Cajal" fellowship at the Optics Department of the Complutense University of Madrid, Spain, while she continues to be an affiliate at JPL, Pasadena. Her research interests include the analysis and design of planar antennas, periodic structures, reflector antennas, lens antennas, waveguide structures, with emphasis in the THz range.

Dr. Llombart was co-recipient of the H. A. Wheeler Award for the Best Applications Paper of 2008 in the IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION. She was also a co-recipient of an Honorable Mention at the 2010 European Conference of Antennas. She serves as Topical Editor for the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

Imran Mehdi (F'10) received the B.S.E.E. degree in 1985, the M.S.E.E. degree in 1986, and the Ph.D . degree in 1990, all from the University of Michigan.

He is currently Principal Member of Engineering staff at the Jet Propulsion Laboratory, California Institute of Technology, Pasadena. His responsibilities include developing THz components and subsystems for current and future NASA missions. He joined JPL in 1990 where his first task included the design and fabrication of low-parasitic planar Schottky diodes for submillimeter-wave applications. These devices were implemented on the ozone monitoring Microwave Limb Sounder instrument which is still operational, as well as the MIRO instrument which represents the first submillimeter-wave receiver that will rendezvous with a comet in 2014. From 1999, he led the effort of developing broadband solid-state sources from 200 to 2500 GHz for the Heterodyne Instrument for Far Infrared (HIFI) on the Herschel Space Observatory, a cornerstone European Space Agency mission currently in space. This effort led to realization of wide-band solid-state sources in the THz range enabling ground-breaking astrophysics observations in space as well as at many ground-based observatories. His current interests include both mm and sub-mm wave devices, semiconductor fabrication technology, high-frequency instrumentation, and heterodyne receivers for miniature systems.

Gun-Sik Park (M'06) received the B.S. degree in physics education from Seoul National University in Korea and the Ph.D degree in physics from the University of Maryland, College Park, in 1978 and 1989, respectively.

During 1987–1995, he worked at Naval Research Laboratory, Washington, DC, through Omega-P, Inc. In 1995, he joined Seoul National University and currently is a Professor in the Department of Physics and Astronomy, and also jointly with the Department of Electrical Engineering at Seoul National University. He leads the Center for THz-Bio Application Systems (2009–2018) at Seoul National University supported by the Ministry of Education, Science and Technology of Korea as a Director.

Dr. Parks' service to journal editor includes *Journal of Korean Physical Society* (JKPS), *Journal of New Physics*, and the *THz Science and Technology*. He serves as a topical editor for IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY, and as a technical committee member of IEEE Electron Devices Society in Vacuum Electronics since 1999. He was a conference chair for 4th IEEE International Vacuum Electronics Conference in 2003 held in Korea and is a co-chair for 34th International Conference on Infrared, Millimeter, and Terahertz Waves in 2009 held in Korea. He is the author of over 100 journal publications in the areas of high power microwaves to terahertz waves.

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Editorial

WELCOME TO OUR FINAL ISSUE in Volume 2 of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY. Since this is a major milestone for us, I would like to take some editorial leeway, and spend a few paragraphs looking back at 2012 and looking forward to 2013.

All of our articles this month come from contributed manuscripts. You will find papers on a THz bolometric camera, a superconducting array receiver, photonic-based and photoconductive detectors, an absolute power meter, micromachining of filters and waveguides, an accurate phase noise measurement technique, a novel photonic crystal-based backward wave oscillator design, and a plasmonic mode excited guiding structure for photoconductive sources. Our THz Pioneer article traces back THz spectroscopy to its origins in the Walter Gordy microwave laboratory of Duke University, through its most prolific and visible proponent, Prof. Frank C. De Lucia of Ohio State University.

I would like to take an opportunity to relay a special thank you this month to all of those whom I was able to meet at the special Reviewers' Reception at the 37th International Conference on Infrared, Millimeter, and Terahertz Waves in Wollongong, South Australia, in September. We have signed up many new and enthusiastic THz journal supporters, who have agreed to help with both reviewing and contributing in the coming year. I would also like to thank the many Topical Editors who were able to attend, and who always give so much volunteer time in support of my own efforts to keep the journal a vibrant high quality outlet for the entire terahertz community.

In looking back over the last year, we have truly come a long way. We have now published 118 articles covering more than 1100 pages. Our submissions have topped 200 manuscripts from 23 countries and include all of our THz topic areas, although some THz subjects remain significantly more popular than others! Our acceptance rate for non-invited articles is currently hovering at approximately 50%, although our reviewers have not been shy about asking authors to keep their standards high, and they do send back articles for major revision in a high percentage of cases. Despite the extra effort this puts on authors, I have had several positive comments, even from those who are being asked to put in extra time on the corrections, about overall improvements to their original submission and, at least in one case, with a thank you for keeping up the standards we have set out to maintain. We hope to continue this policy so that as much as possible, we can provide you content that has both high technical and grammatical quality.

I would be remiss if I did not admit that we have had several instances of overly drawn out reviews, insufficient feedback to authors, and missteps over some papers. Although these have not been excessive, there is no excuse for even a small number of such failings on our part, and we welcome your criticism and your inquiries whenever our progress is not up to your expectations. Those of you who have contacted us about such issues, hopefully have found us to be attentive, apologetic and responsive. If not, you have my e-mail and my phone number—do not hesitate to contact me directly.

Although we are still too young to sport an official impact factor, our campaign to distribute IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY to a wide readership has been extremely successful. We have sent out more than 12 000 print issues each month since our inception, to a very diverse community of subscribers. Our "free subscription" campaign has brought us almost 1800 new journal recipients, more than 60% of who are outside of the IEEE community. With our continued strong administrative and financial support from the IEEE Microwave Theory and Techniques Society, we hope to continue this free subscription campaign into 2013. We have also distributed free copies of the journal at more than a dozen THz conferences and workshops worldwide, and I look forward to meeting some of you, as well as newcomers to the journal, this February 3rd through 7th at our booth at the Photonics West symposia in San Francisco, CA, USA. If you are attending, please stop by, and of course spread the word to colleagues who might be attending.

In the coming year, we have arranged a special mini-issue scheduled for January 2013 covering expanded papers from the 23rd International Symposium on Space Terahertz Technology (ISSTT). Dr. Hiroshi Matsuo of the National Astronomical Observatory of Japan is the Guest Editor-in-Chief, with support from Topic Editor, Prof. Chris Walker. We are also putting together a full special issue on Terahertz Spectroscopy for May 2013, with our own Prof. Peter Uhd Jepsen and McGill University's Prof. David Cooke as special issue editors. Our first joint special issue—in collaboration with the IEEE JOURNAL OF BIOMEDICAL AND HEALTH INFORMATICS (J-BHI)—is focused on Terahertz biology and biomedical applications. This is scheduled to appear as a J-BHI publication in the spring of 2013. It has two of our own Topic Editor's, Dr. Gian Piero Gallerano and Prof. Gun-Sik Park, as J-BHI special issue guest editors. If you are interested in suggesting other special or joint issues, please feel free to express your ideas in an email to the Editor-in-Chief, or to any of our experienced Topic Editors.

Finally, I would like to announce *"Best Paper Prize"* for articles that have appeared in this TRANSACTIONS since our Inaugural Issue last September 2011. Our review board is beginning to collect nominations and we welcome suggestions from all of you. If you have a favorite, please send the article title with a short discussion on the reasons behind your selection to me at phs@caltech.edu before the 15th of December.

Now please turn the page to start reading Volume 2, Issue 6, of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

Yours sincerely,

Digital Object Identifier 10.1109/TTHZ.2012.2224234

PETER H. SIEGEL, *Editor-in-Chief*

Peter H. Siegel (S'77–M'83–SM'98–F'01) received the B.A. degree from Colgate University, Hamilton, NY, in 1976, and the Ph.D. degree from Columbia University, New York, in 1983.

He holds appointments as Faculty Associate in Electrical Engineering and Senior Scientist in Biology at Caltech and Senior Research Scientist at the Jet Propulsion Laboratory (JPL) in Pasadena, CA. He has been working in the areas of millimeter and submillimeter-wave technology and applications for 35 years and has PI'd or co-I'd more than 75 R&D programs and been involved in four major space flight instruments. He has published more than 275 articles in the THz field and has given more than 100 invited talks in the US and abroad on this subject. At JPL, he founded, and led for more than 20 years, the JPL Submillimeter Wave Advanced Technology (SWAT) team, a group of 20+ research scientists and engineers developing THz technology for NASA's near and long term space missions as well as for several DoD applications. At Caltech, Dr. Siegel is involved in new biological and medical applications of THz. His current interests are split between traditional Earth, planetary and astrophysics applications and new THz applications in medicine and biology.

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EXECUTIVE EDITOR

Dylan F. Williams (M'80–SM'90–F'02) received the Ph.D. degree in electrical Engineering from the University of California, Berkeley in 1986. He joined the Electromagnetic Fields Division of the National Institute of Standards and Technology, Boulder, CO, in 1989, where he develops electrical waveform and microwave metrology. He has published over 80 technical papers.

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Stefano Alberti received the Ph.D. degree from the Swiss Federal Institute of Technology (EPFL), Lausanne, Switzerland, in 1991, with his research dedicated to the study of quasi-optical gyrotrons.

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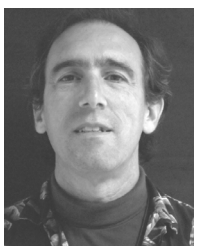

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Kodo Kawase received B.S. degree in electronic engineering from Kyoto University in 1989, and Ph.D degree in electronic engineering from Tohoku University in 1996.

He became an Initiative Researcher at RIKEN in 2001. He became a Professor of Graduate School of Engineering, Nagoya University, Japan, in 2005. He has been conducting research activities in several directions within the THz field. He developed several types of widely tunable THz sources using nonlinear optical effects, and suggested a whole range of real-life applications. He has published more than 130 articles in the THz field and has given more than 160 invited talks on this subject.

Dr. Kawase received the 1997 Young Scientist Award from the JSAP, the 1998 Excellent Presentation Award, the 2000 and 2006 Prize of Laser Engineering from the Laser Society of Japan, the 2002 Marubun research and encouragement award and 2006 Marubun Special Research Award by the Marubun Research Promotion Foundation (MRPF), and the the 2005 Young Scientists' Prize by the Commendation for Science and Technology by the Minister of Education, Culture, Science and Technology (MEXT).

Martin Koch was born in Marburg, Germany in 1963. He received the Diploma and Ph.D. degree form the University of Marburg in 1991 and 1995, respectively.

From 1995 to 1996 he was a post-doctorate at Bell Labs/Lucent Technologies, Holmdel, NJ. From 1996 to 1998 worked in the photonics and optoelectronics group at the University of Munich. From 1998 to 2008 he was associate professor at the Technical University of Braunschweig. In 2003, he did a three-month sabbatical at the University of California in Santa Barbara. Since 2009 he is full professor of physics at the Philipps University Marburg, Germany. His research interests are terahertz systems and their applications, semiconductor disk lasers and ultrafast spectroscopy on semiconductors.

In 2003, Dr. Koch was awarded the Kaiser-Friedrich Research Prize.

Nuria Llombart received the Electrical Engineering degree and Ph.D. degree from the Polytechnic University of Valencia, Spain, in 2002 and 2006 respectively.

During her Master's degree studies she spent one year at the Friedrich-Alexander University of Erlangen-Nuremberg, Germany, and worked at the Fraunhofer Institute for Integrated Circuits, Erlangen, Germany. From 2002 until 2007, she was with the Antenna Group at the TNO Defence, Security and Safety Institute, The Hague, The Netherlands, working as Ph.D. student and afterwards as researcher. From 2007 until 2010, she was a Post-Doctoral Fellow at the California Institute of Technology, working for the Sub millimeter Wave Advance Technology group of the Jet Propulsion Laboratory (JPL), Pasadena, CA. Currently, she holds a "Ramón y Cajal" fellowship at the Optics Department of the Complutense University of Madrid, Spain, while she continues to be an affiliate at JPL, Pasadena. Her research interests include the analysis and design of planar antennas, periodic structures, reflector antennas, lens antennas, waveguide structures, with emphasis in the THz range.

Dr. Llombart was co-recipient of the H. A. Wheeler Award for the Best Applications Paper of 2008 in the IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION. She was also a co-recipient of an Honorable Mention at the 2010 European Conference of Antennas. She serves as Topical Editor for the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

Imran Mehdi (F'10) received the B.S.E.E. degree in 1985, the M.S.E.E. degree in 1986, and the Ph.D . degree in 1990, all from the University of Michigan.

He is currently Principal Member of Engineering staff at the Jet Propulsion Laboratory, California Institute of Technology, Pasadena. His responsibilities include developing THz components and subsystems for current and future NASA missions. He joined JPL in 1990 where his first task included the design and fabrication of low-parasitic planar Schottky diodes for submillimeter-wave applications. These devices were implemented on the ozone monitoring Microwave Limb Sounder instrument which is still operational, as well as the MIRO instrument which represents the first submillimeter-wave receiver that will rendezvous with a comet in 2014. From 1999, he led the effort of developing broadband solid-state sources from 200 to 2500 GHz for the Heterodyne Instrument for Far Infrared (HIFI) on the Herschel Space Observatory, a cornerstone European Space Agency mission currently in space. This effort led to realization of wide-band solid-state sources in the THz range enabling ground-breaking astrophysics observations in space as well as at many ground-based observatories. His current interests include both mm and sub-mm wave devices, semiconductor fabrication technology, high-frequency instrumentation, and heterodyne receivers for miniature systems.

Gun-Sik Park (M'06) received the B.S. degree in physics education from Seoul National University in Korea and the Ph.D degree in physics from the University of Maryland, College Park, in 1978 and 1989, respectively.

During 1987–1995, he worked at Naval Research Laboratory, Washington, DC, through Omega-P, Inc. In 1995, he joined Seoul National University and currently is a Professor in the Department of Physics and Astronomy, and also jointly with the Department of Electrical Engineering at Seoul National University. He leads the Center for THz-Bio Application Systems (2009–2018) at Seoul National University supported by the Ministry of Education, Science and Technology of Korea as a Director.

Dr. Parks' service to journal editor includes *Journal of Korean Physical Society* (JKPS), *Journal of New Physics*, and the *THz Science and Technology*. He serves as a topical editor for IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY, and as a technical committee member of IEEE Electron Devices Society in Vacuum Electronics since 1999. He was a conference chair for 4th IEEE International Vacuum Electronics Conference in 2003 held in Korea and is a co-chair for 34th International Conference on Infrared, Millimeter, and Terahertz Waves in 2009 held in Korea. He is the author of over 100 journal publications in the areas of high power microwaves to terahertz waves.

Jan Stake (M'95) received the M.Sc. degree in electrical engineering and Ph.D. degree in microwave electronics from Chalmers University of Technology, Göteborg, Sweden, in 1994 and 1999, respectively.

In 1997, he was a Research Assistant at the University of Virginia, Charlottesville. From 1999 to 2001, he was a Research Fellow in the millimeter wave group at the Rutherford Appleton Laboratory, U.K. He then joined Saab Combitech Systems AB as a Senior RF/microwave Engineer until 2003. From 2000 to 2006, he held different academic positions at Chalmers and was also Head of the Nanofabrication Laboratory at MC2 between 2003 and 2006. During 2007, he was a Visiting Professor in the Submillimeter Wave Advanced Technology (SWAT) group at Caltech/JPL, exploring THz applications in biology and medicine. He is currently Professor and Head of the Terahertz and Millimetre Wave Laboratory, Chalmers. His research involves terahertz sources, detectors and mixers, high frequency semiconductor devices, graphene electronics, terahertz measurement techniques and applications.

Christopher Walker has over 25 years experience designing, building, and using state-of-the-art receiver systems for THz astronomy. He is a Professor of Astronomy and an Associate Professor of Optical Sciences and Electrical Engineering at the University of Arizona (UofA). He has worked in industry (TRW Aerospace and JPL) as well as academia. As a Millikan Fellow in Physics at Caltech, he worked on the development of low-noise, SIS waveguide receivers above 400 GHz and explored techniques for etching waveguide out of silicon. On joining the UofA faculty in 1991 he began the Steward Observatory Radio Astronomy Lab (SORAL), which has become a world leader in developing THz receiver systems for astronomy and other remote sensing applications. These instruments are multi-institutional efforts, with key components coming from JPL, several universities, and a number of industrial partners. He manages and coordinates these efforts. Instruments developed by Prof. Walker's team have served as primary facility instruments at the Heinrich Hertz Telescope on Mt. Graham, AZ, and the AST/RO telescope at the South Pole. He is leading the effort to design and build the world's largest (64 pixels) submillimeter-wave heterodyne array receiver (SuperCam). He is also PI of the NASA funded long duration balloon project "The Stratospheric THz Observatory (STO)". He has published numerous papers on star formation and protostellar evolution. He has served as dissertation director for nine Ph.D. students.

Editorial

WHAT a great pleasure it is for all of us on the Editorial Board to welcome you to Volume 3 of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

I am extremely excited about the prospect for great things this coming year. In addition to our regular and focus articles, we are preparing two special issues. Our May issue (Volume 3, Number 3) is dedicated to Terahertz Spectroscopy. We already have 10 selected topics and papers that cover molecular spectroscopy of gases in the interstellar medium, liquid and solid phase THz spectroscopy, non-linear spectroscopy, applications in solid-state physics, biology, and materials science, and both frequency and time domain methods. This special issue is being guided by guest editor David Cooke of McGill University, Montreal, Canada, and our own Peter Uhd Jepsen, Technical University of Denmark.

This coming fall we are planning a second special issue on Terahertz Metamaterials, with the Call for Papers appearing at the end of this issue. Special guest editors include Dr. Tahsin Akalin, Lille University, France, Willie Padilla, Boston College, USA, Marco Rahm, and our own Rene Beigang, both of University of Kaiserslautern, Germany. Rene is also chairing the *38th International Conference on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz)* to be held in Mainz, Germany, in September 2013.

We are also in the process of finalizing our first Joint Special Issue with the IEEE JOURNAL OF BIOMEDICAL AND HEALTH INFORMATICS (J-BHI) on Terahertz Imaging and Spectroscopy for Biology and Biomedicine. Professor Emma MacPherson at the Hong Kong University of Science and Technology is leading this special issue with IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY topic editors Gun Sik Park (Seoul National University, Korea) and Gian Piero Gallerano (ENEA Frascati, Rome, Italy), among the supporting special issue editors.

We intend to continue with our well received "*THz Pioneer*" articles this year, and have a series of interviews lined up that I am sure will catch the attention of even the most diverse members of our cross-disciplinary community. In this issue, we are extremely fortunate to have had the opportunity to speak with Professor Federico Capasso of Harvard University, Cambridge, MA, USA, who of course is best known within the THz community for his development of the Quantum Cascade Laser. However, I am certain you will be equally pleased reading about his many other contributions to science and technology, as well as his ebullient approach to teaching and research.

For this, our opening issue of the New Year, we continue in our tradition of including a special mini-topic-section. We again celebrate the world's oldest continuous conference devoted exclusively to THz science and applications: the *International Symposium on Space Terahertz Technology (ISSTT)*, which completed its 23rd successive meeting in 2012. Expanded papers from the conference appear as a Special Supplement to this January regular issue.

The *ISSTT* conference series started in 1990 under the joint sponsorship of the NASA Jet Propulsion Laboratory and the University of Michigan Center for Space Terahertz Technology. It was originally conceived, set up, and directed by notable Michigan Professor of Electrical Engineering, Dr. Fawwaz Ulaby, as well as JPL's Dr. Margaret Frerking and Dr. Carl Kukkonen, both early pioneers in the development and promotion of THz space science. The conference took on a life of its own in 1993, even before the Michigan Center ended in 1995, and has been a well attended yearly event ever since.

ISSTT has focused exclusively on terahertz sensors, sources, and instruments for its full 23 years, and has consistently produced a high quality digest with extremely detailed papers that are now fully accessible through a server maintained by the National Radio Astronomy Observatory in Charlottesville, VA, USA (http://www.nrao.edu/meetings/isstt/index.shtml).

Having participated in many of these focused meetings, starting from the very first, it is a great privilege to bring papers from this conference to the broader terahertz community by highlighting some of the contributions that have been submitted by attendees at *ISSTT 23* held this past April 2–4 in Tokyo, Japan. Our special Mini-Issue Guest Editor is Dr. Hiroshi Matsuo of the National Astronomical Observatory of Japan and he was assisted by our own Chris Walker, from the University of Arizona. Dr. Matsuo has collected the papers that appear in this issue and has escorted them through our regular review process. He has also contributed a more detailed introduction to this year's collection of articles that appears as a Front Piece to the mini-issue.

Since we have so many contributed ISSTT papers this year, we included only 4 regular paper contributions in this issue. These cover two very interesting and novel waveguide structures, that I am sure which catch your attention; a new room temperature micro-bridge bolometer suitable for planar array architectures; and an ambitious THz space telescope concept with a large focal plane array.

Finally, I apologize for the rather late print mailing of the November issue (which did not actually arrive until mid-December). The delay was caused by hurricane Sandy, which shut down IEEE operations at the New Jersey headquarters for almost three weeks. As you can see, these great folks are back up and operating again, and doing their utmost to bring you these publications on schedule. A very special thanks goes to our Managing Editor in New Jersey, Ms. Mona Mittra, who has been especially helpful in making sure every issue of this journal is assembled, printed and mailed, despite all the natural, and *Editor-in-Chief*-generated, delays, and mishaps that plague her and her staff as every deadline approaches.

I would like to express my sincerest thanks to all of you for continuing to support the journal with your technical contribu-

Digital Object Identifier 10.1109/TTHZ.2012.2236920

tions and your willingness to serve as reviewers for our contributed manuscripts, and of course I would like to reiterate my thanks to all the dedicated folks who serve as Topic and Administrative Editors, without whom we would not be able to bring you—Volume 3, Issue 1, of IEEE TRANSACTIONS OF TERAHERTZ SCIENCE AND TECHNOLOGY. . . . Happy Reading!

Yours sincerely,

PETER H. SIEGEL, *Editor-in-Chief*

Peter H. Siegel (S'77–M'83–SM'98–F'01) received the B.A. degree from Colgate University, Hamilton, NY, in 1976, and the Ph.D. degree from Columbia University, New York, in 1983.

He holds appointments as Faculty Associate in Electrical Engineering and Senior Scientist in Biology at Caltech and Senior Research Scientist at the Jet Propulsion Laboratory (JPL) in Pasadena, CA. He has been working in the areas of millimeter and submillimeter-wave technology and applications for 35 years and has PI'd or co-I'd more than 75 R&D programs and been involved in four major space flight instruments. He has published more than 275 articles in the THz field and has given more than 100 invited talks in the US and abroad on this subject. At JPL, he founded, and led for more than 20 years, the JPL Submillimeter Wave Advanced Technology (SWAT) team, a group of 20+ research scientists and engineers developing THz technology for NASA's near and long term space missions as well as for several DoD applications. At Caltech, Dr. Siegel is involved in new biological and medical applications of THz. His current interests are split between traditional Earth, planetary and astrophysics applications and new THz applications in medicine and biology.

Among many other duties, Dr. Siegel co-chaired and chaired for six years, and is now General Secretary for the International Conference for Infrared, Millimeter and Terahertz Waves (IRMMW-THz), the oldest and largest venue devoted to the field of far IR techniques, science and applications, and he served as conference organizer and chair for IRMMW-THz 2008 in Pasadena. He also set up and administers the International Society of Infrared, Millimeter and Terahertz Waves in 2010, a non-profit organization that is responsible for overseeing the conference series. He has served as an IEEE Distinguished Microwave Lecturer, co-chair and chair of MTT Committee 4-THz Technology, a TPC and Speaker's bureau member, and as organizer and chair of seven sequential special sessions at the IEEE International Microwave Symposia. He is extremely pleased, and very excited to be involved in the formation and launching of the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY. (His Web Pages: http://www.thz.caltech.edu; http://www.irmmw-thz.org; http://www.thz.ieee.org, e-mail: phs@caltech.edu).

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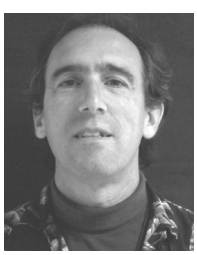

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He became an Initiative Researcher at RIKEN in 2001. He became a Professor of Graduate School of Engineering, Nagoya University, Japan, in 2005. He has been conducting research activities in several directions within the THz field. He developed several types of widely tunable THz sources using nonlinear optical effects, and suggested a whole range of real-life applications. He has published more than 130 articles in the THz field and has given more than 160 invited talks on this subject.

Dr. Kawase received the 1997 Young Scientist Award from the JSAP, the 1998 Excellent Presentation Award, the 2000 and 2006 Prize of Laser Engineering from the Laser Society of Japan, the 2002 Marubun research and encouragement award and 2006 Marubun Special Research Award by the Marubun Research Promotion Foundation (MRPF), and the the 2005 Young Scientists' Prize by the Commendation for Science and Technology by the Minister of Education, Culture, Science and Technology (MEXT).

Martin Koch was born in Marburg, Germany in 1963. He received the Diploma and Ph.D. degree form the University of Marburg in 1991 and 1995, respectively.

From 1995 to 1996 he was a post-doctorate at Bell Labs/Lucent Technologies, Holmdel, NJ. From 1996 to 1998 worked in the photonics and optoelectronics group at the University of Munich. From 1998 to 2008 he was associate professor at the Technical University of Braunschweig. In 2003, he did a three-month sabbatical at the University of California in Santa Barbara. Since 2009 he is full professor of physics at the Philipps University Marburg, Germany. His research interests are terahertz systems and their applications, semiconductor disk lasers and ultrafast spectroscopy on semiconductors.

In 2003, Dr. Koch was awarded the Kaiser-Friedrich Research Prize.

Nuria Llombart received the Electrical Engineering degree and Ph.D. degree from the Polytechnic University of Valencia, Spain, in 2002 and 2006 respectively.

During her Master's degree studies she spent one year at the Friedrich-Alexander University of Erlangen-Nuremberg, Germany, and worked at the Fraunhofer Institute for Integrated Circuits, Erlangen, Germany. From 2002 until 2007, she was with the Antenna Group at the TNO Defence, Security and Safety Institute, The Hague, The Netherlands, working as Ph.D. student and afterwards as researcher. From 2007 until 2010, she was a Post-Doctoral Fellow at the California Institute of Technology, working for the Sub millimeter Wave Advance Technology group of the Jet Propulsion Laboratory (JPL), Pasadena, CA. Currently, she holds a "Ramón y Cajal" fellowship at the Optics Department of the Complutense University of Madrid, Spain, while she continues to be an affiliate at JPL, Pasadena. Her research interests include the analysis and design of planar antennas, periodic structures, reflector antennas, lens antennas, waveguide structures, with emphasis in the THz range.

Dr. Llombart was co-recipient of the H. A. Wheeler Award for the Best Applications Paper of 2008 in the IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION. She was also a co-recipient of an Honorable Mention at the 2010 European Conference of Antennas. She serves as Topical Editor for the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

Imran Mehdi (F'10) received the B.S.E.E. degree in 1985, the M.S.E.E. degree in 1986, and the Ph.D . degree in 1990, all from the University of Michigan.

He is currently Principal Member of Engineering staff at the Jet Propulsion Laboratory, California Institute of Technology, Pasadena. His responsibilities include developing THz components and subsystems for current and future NASA missions. He joined JPL in 1990 where his first task included the design and fabrication of low-parasitic planar Schottky diodes for submillimeter-wave applications. These devices were implemented on the ozone monitoring Microwave Limb Sounder instrument which is still operational, as well as the MIRO instrument which represents the first submillimeter-wave receiver that will rendezvous with a comet in 2014. From 1999, he led the effort of developing broadband solid-state sources from 200 to 2500 GHz for the Heterodyne Instrument for Far Infrared (HIFI) on the Herschel Space Observatory, a cornerstone European Space Agency mission currently in space. This effort led to realization of wide-band solid-state sources in the THz range enabling ground-breaking astrophysics observations in space as well as at many ground-based observatories. His current interests include both mm and sub-mm wave devices, semiconductor fabrication technology, high-frequency instrumentation, and heterodyne receivers for miniature systems.

Gun-Sik Park (M'06) received the B.S. degree in physics education from Seoul National University in Korea and the Ph.D degree in physics from the University of Maryland, College Park, in 1978 and 1989, respectively.

During 1987–1995, he worked at Naval Research Laboratory, Washington, DC, through Omega-P, Inc. In 1995, he joined Seoul National University and currently is a Professor in the Department of Physics and Astronomy, and also jointly with the Department of Electrical Engineering at Seoul National University. He leads the Center for THz-Bio Application Systems (2009–2018) at Seoul National University supported by the Ministry of Education, Science and Technology of Korea as a Director.

Dr. Parks' service to journal editor includes *Journal of Korean Physical Society* (JKPS), *Journal of New Physics*, and the *THz Science and Technology*. He serves as a topical editor for IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY, and as a technical committee member of IEEE Electron Devices Society in Vacuum Electronics since 1999. He was a conference chair for 4th IEEE International Vacuum Electronics Conference in 2003 held in Korea and is a co-chair for 34th International Conference on Infrared, Millimeter, and Terahertz Waves in 2009 held in Korea. He is the author of over 100 journal publications in the areas of high power microwaves to terahertz waves.

Jan Stake (M'95) received the M.Sc. degree in electrical engineering and Ph.D. degree in microwave electronics from Chalmers University of Technology, Göteborg, Sweden, in 1994 and 1999, respectively.

In 1997, he was a Research Assistant at the University of Virginia, Charlottesville. From 1999 to 2001, he was a Research Fellow in the millimeter wave group at the Rutherford Appleton Laboratory, U.K. He then joined Saab Combitech Systems AB as a Senior RF/microwave Engineer until 2003. From 2000 to 2006, he held different academic positions at Chalmers and was also Head of the Nanofabrication Laboratory at MC2 between 2003 and 2006. During 2007, he was a Visiting Professor in the Submillimeter Wave Advanced Technology (SWAT) group at Caltech/JPL, exploring THz applications in biology and medicine. He is currently Professor and Head of the Terahertz and Millimetre Wave Laboratory, Chalmers. His research involves terahertz sources, detectors and mixers, high frequency semiconductor devices, graphene electronics, terahertz measurement techniques and applications.

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Editorial

THIS month marks a turning point in our new journal. We now have accumulated a paper queue that extends beyond our upcoming issue. This is a good indication that our readership is growing, and we are increasing our reach into the wider THz community. Note that the print release queue does not impact the electronic postings, and authors can still expect to see their unpaginated articles on IEEEXplore as soon as they are completed and proofed.

Our March 2013 issue contains regular paper contributions only. These span topics from submillimeter-wave CMOS circuits to an RF model of human skin at 450 GHz. This month's THz Pioneer article takes us to Japan for the first time, where we hear from one of the first THz researchers and advocates in Asia, Professor Koji Mizuno, from Tohoku University, Sendai.

On the technical side, our lead off paper by *A. Tang (JPL) and F. Chang (UCLA)* on a new type of receiver architecture (intermodulated regenerative receiver) that can get above the cut-off frequency of 65 and 40 nm CMOS circuits, is of particular interest.

This paper is followed by a submission from Tel Aviv University (*B. Khamaisi, S. Jameson, and E. Socher*) that carries on the submillimeter-wave CMOS revolution, with a complete design and measurement sequence for a 90 nm CMOS VCO, antenna, and transmitter circuit.

Y. Yang and D. Grischkowsky have contributed a paper on measuring spoof-surface plasmon interactions (surface waves) with subwavelength metallic-hole arrays from 500 GHz to 3 THz. They achieve excellent agreement with theory, with the exception of an unpredicted anomalous reflection dip at 1.49 THz that has yet to be explained. . .

The THz group from NTT, Japan *(J.-Y. Kim, H. J. Song, K. Ajito, M. Yaita, and N. Kukutsu)* have used wideband uni-traveling-carrier photodiodes (UTC-PD) and photoconductive antennas in a novel electro-optic circuit to successfully demonstrate fast (30 ms per pixel) THz spectroscopy and imaging up to 1.5 THz.

Imaging applications are further demonstrated in a very nice paper by *J. Szelc and H. Rutt* at University of Southampton, who have fabricated a 16 pixel near-field imaging array at 2.5 THz with a resolution of 30 microns $(\lambda/4)$.

A large combined team from University of Karlsruhe, Germany, and University of Leeds, U.K. (*A. Scheuring et al.*) that includes our own Giles Davies, use time domain analysis and new high $\mathrm{T_c}$ YBCO and NbN superconducting detectors to resolve quantum cascade laser pulses on a nanosecond scale. Some never-before-measured transient features have been observed in the QCL devices.

A team from the National Astronomical Observatory (NAO) in Japan and several university groups (*M. Naruse et al.*) contribute a nice MKID (microwave kinetic inductance detector) article that goes a long way to demonstrating the eventual realization of a super-high sensitivity THz camera. Their paper describes a nine element integrated 220 GHz MKID camera with an electrical NEP approaching 10^{-18} W/$\sqrt{}$Hz.

High speed (broad intermediate frequency bandwidth) hot electron bolometer mixers are the topic of our next paper from the THz groups at NTT and Chalmers University, Sweden (*S. Bevilacqua et al.*, *including J. Stake*). A nice thermal analysis helps explain the observed device characteristics.

J. T. Surek et al. from National Institute of Standards and technology, Boulder, CO, USA, describe a practical multilayer quarter-wave matching structure for optical beams in the millimeter and submillimeter-wavelength bands.

K. Iwaszczuk et al., including our own P. Uhd Jepsen, sent in an article analyzing a whispering gallery mode THz resonator with good coupling to a Gaussian output beam. We are looking forward to a demonstration in the near future.

We hear from Notre Dame University, IN, USA (*B. Sensale-Rodriguez et al.*) on predictions of THz amplification from high electron mobility transistors (Dyakonov-Shur effect).

The group from Hebrew University, Jerusalem, Israel, that generated much excitement several years ago when they proposed a millimeter-wave antenna model for human sweat ducts (*I. Hayut et al.*), submit an article that carries their model into the submillimeter-wave regime with predicted spectral responses at 380 GHz.

Finally, from down-under, we present an article by the well-known group from Adelaide, South Australia (*B. S.-Y. Ung et al.*) on a simultaneous transmit/reflect THz time-domain technique.

On the home front, we say farewell to three very valued members of our Editorial team: Martin Koch, Jack East, and Gun-Sik Park, who are stepping aside from their founding Topic Editor roles. I think I speak for all of us in thanking them most sincerely for their support and guidance in getting the journal started, and for their tireless management of the paper submission and reviewer sequences in their topic areas. I will personally miss them very much.

At the same time, we are very excited, and honored, to have Professor Victor Lubecke from University of Hawaii coming on board to substitute for Jack East in THz Devices, Professor Haewook Han from Pohang University of Science and Technology, Korea, stepping in for Gun-Sik Park in THz modeling and analysis, and we are grateful to Rene Beigang, who is moving over to NDE and industrial applications, to replace Martin Koch.

Finally, I am very sorry to have to report that we are losing our staunchest THz journal advocate, and a personal mentor in this endeavor, Dr. Dylan Williams, who is relinquishing his role as Executive Editor to take on a larger responsibility as Chair of the Microwave Theory and Techniques Society's Publications Committee. Dylan, along with Samir Ghazaly, Madhu Gupta, Jack East, Erich Grossman, Dwight Woolard

Digital Object Identifier 10.1109/TTHZ.2013.2245777

and John Whitaker, formed the original IEEE advocacy team that put this journal on the books after a continuous two-year struggle. We all owe Dylan a heartfelt thanks for everything he has contributed to our success and hope that we will continue to receive his articles as regular contributions to our publication.

Now I am certain you are anxious to get to some real technical content, so please turn the pages until you reach the start of Volume 3, Issue 2 of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

Yours sincerely,

PETER H. SIEGEL, *Editor-in-Chief*

Peter H. Siegel (S'77–M'83–SM'98–F'01) received the B.A. degree from Colgate University, Hamilton, NY, in 1976, and the Ph.D. degree from Columbia University, New York, in 1983.

He holds appointments as Faculty Associate in Electrical Engineering and Senior Scientist in Biology at Caltech and Senior Research Scientist at the Jet Propulsion Laboratory (JPL) in Pasadena, CA. He has been working in the areas of millimeter and submillimeter-wave technology and applications for 38 years and has PI'd or co-I'd more than 75 R&D programs and been involved in four major space flight instruments. He has published more than 275 articles in the THz field and has given more than 150 invited talks in the US and abroad on this subject. At JPL, he founded, and led for more than 20 years, the JPL Submillimeter Wave Advanced Technology (SWAT) team, a group of 20+ research scientists and engineers developing THz technology for NASA's near and long term space missions as well as for several DoD applications. At Caltech, Dr. Siegel is involved in new biological and medical applications of THz. His current interests are split between traditional Earth, planetary and astrophysics applications and new THz applications in medicine and biology.

Among many other duties, Dr. Siegel co-chaired and chaired for six years, and is now General Secretary for the International Conference for Infrared, Millimeter and Terahertz Waves (IRMMW-THz), the oldest and largest venue devoted to the field of far IR techniques, science and applications, and he served as conference organizer and chair for IRMMW-THz 2008 in Pasadena. He also set up and administers the International Society of Infrared, Millimeter and Terahertz Waves in 2010, a non-profit organization that is responsible for overseeing the conference series. He has served as an IEEE Distinguished Microwave Lecturer, co-chair and chair of MTT Committee 4-THz Technology, a TPC and Speaker's bureau member, and as organizer and chair of seven sequential special sessions at the IEEE International Microwave Symposia. He is extremely pleased, and very excited to be involved in the formation and launching of the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY. (His Web Pages: http://www.thz.caltech.edu; http://www.irmmw-thz.org; http://www.thz.ieee.org, e-mail: phs@caltech.edu).

ADMINISTRATIVE EDITOR

Sharri Shaw was born in Michigan, and currently resides in Boulder, CO. She received the B.A. degree in english and a minor in psychology, from Saginaw Valley State University, in 1994. She continued her studies in 2001 in the Master in Education with Initial Certification (M.Ed.) program at Aquinas College, where she received her Secondary Level Teacher Certification.

From 2002 to 2005, she was a teacher in Michigan. From 2006 to 2010, she was the Assistant Editor of the IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES. She currently holds the same position with *IEEE Microwave Magazine*, and also serves as the Publications Administrator for the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

TOPIC EDITORS

Stefano Alberti received the Ph.D. degree from the Swiss Federal Institute of Technology (EPFL), Lausanne, Switzerland, in 1991, with his research dedicated to the study of quasi-optical gyrotrons.

After a two-year post-doctorate at MIT, Cambridge, where he worked on CARMs and X-Band relativistic-TWT, he returned in 1993 to the Centre for Plasma Physics Research (CRPP), EPFL. Since then, within the European high-power gyrotron development program, he worked at CRPP developing and testing high-power high-frequency gyrotrons for a variety of EC-system installed on magnetically confined plasma experiments, such as TCV at CRPP, Tore-Supra, W7-X and presently ITER. In parallel to this activity, he contributed to the design, installation and testing of complete electron-cyclotron system from plug to plasma for these same experiments. On TCV he actively contributed on performing electron-cyclotron heating and current-drive experiments. Since 2008, he is responsible for the development of frequency-tunable gyrotrons for DNP-enhanced NMR-spectroscopy. He is currently Lecturer at EPFL, where he teaches an introductory course in plasma physics. He is the author or coauthor of over 60 refereed publications.

René Beigang received the Diploma and Ph.D. degrees from the University of Hannover, Hannover, Germany.

He spent 3 years as a post-doctorate and visiting scientist at the IBM T. J. Watson Research Center, Yorktown Heights, NY. He was Associate Professor at the Free University of Berlin and the University of Kaiserslautern. He is now a full professor at the Department of Physics of the University of Kaiserslautern. Since 2005, he is also Head of the Department on Terahertz Measurement and Systems of the Fraunhofer Institute for Physical Measurement Techniques. His current research interests include nonlinear optics, generation and application of THz radiation, THz spectroscopy, applications of THz radiation in science and technology, realization and investigation of THz meta materials. (His homepage: http://www.physik.uni-kl.de/beigang).

A. Giles Davies received the B.Sc. degree in chemical physics from the University of Bristol, Bristol, U.K., in 1987, and the Ph.D. degree in semiconductor physics from the University of Cambridge, Cambridge, U.K., in 1991.

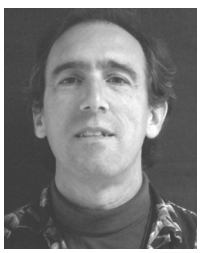
He is currently Professor of Electronic and Photonic Engineering at the University of Leeds, Leeds, U.K. His research interests concentrate on the electrical and optical properties of low- dimensional and nanostructured electronic systems, and multilayered semiconductor devices, with particular recent focus on the development of terahertz frequency systems and the exploitation of biological processes for nanoscale assembly.

Gian Piero Gallerano received the Laurea Degree (Ph.D.) in physics from the University of Rome, Italy in 1980 with a thesis on the realization of a tunable color center laser in the near infrared.

In 1981, he was a Visiting Fellow at the Technical University Hannover, Germany. In 1983 he joined the High Power Laser Laboratory at ENEA Research Center, Frascati to work on the development of infrared free electron lasers (FEL). In 1991 he was a Visiting Scholar at the Ginzton Laboratory, EE Dept, Stanford University. His work on FELs lead to the realization of the ENEA Compact FEL (90–150 GHz) and of the Compact Advanced THz Source, FEL-CATS (0.4–0.7 THz). From 2001 to 2004 he has been the Coordinator of the European project THz-BRIDGE involving ten research

institutes in the study the interaction of THz radiation with biological systems. From 2005 to 2007, he was in charge of the ENEA participation in the European project EUROFEL. He is currently the Head of the Radiation Sources Laboratory at ENEA Frascati. His areas of interest include generation of THz radiation and its application in the biological, biomedical, environmental and art conservation fields, THz imaging techniques, coherent emission from RF modulated electron beams, free electron lasers, optical design and diagnostics in the infrared.

Dr. Gallerano organized the "35th International Conference on Infrared, Millimeter and THz Waves" IRMMW-THz 2010 held in Rome, Italy, September 5–10, 2010., and currently chairs the International Society of Infrared, Millimeter and Terahertz Waves, the oldest and largest forum devoted to scientific and technological developments in the wide spectral range extending from the infrared to the millimeter wave region. He has been a member of the Italian Physical Society since 1981, and is a member of the Bioelectromagnetics Society.



Erich N. Grossman received the A.B. degree in physics from Harvard College, Cambridge, MA, in 1980, and a Ph.D. degree, also in physics, from the California Institute of Technology, Pasadena, in 1987. His thesis work involved development of an ultra-low noise, heterodyne receiver for 2 THz astronomy.

From 1988 to 1989, he was a post-doctoral fellow at the University of Texas at Austin, TX, USA, and in 1989, he joined the National Institute of Standards and Technology, Boulder, CO, USA, where he is now a physicist in the Optoelectronics Division. His work at NIST focuses on infrared and submillimeter system development.

Dr. Grossman's notable accomplishments include the development and demonstration of the world's highest frequency, high efficiency lithographic antennas, the world's highest frequency Josephson junctions, (awarded a Department of Commerce Gold Medal in 1993), and early conception and development of the SQUID multiplexer, first enabling large monolithic arrays of superconducting detectors. More recently, he has developed several 0.1–1 THz cameras for security applications. He is also chair of the Metrology Working Group for the DARPA Terahertz Electronics program.

Haewook Han (M'12) received the B.S. and M.S. degrees in electrical engineering from Seoul National University, Seoul, Korea, in 1986 and 1988, respectively, and the Ph.D. degree in electrical engineering from the University of Illinois at Urbana-Champaign, Urbana, IL, USA, in 1995.

He studied low-threshold strained quantum-well heterostructure lasers and two-dimensional photonic crystal semiconductor lasers. At Bell Laboratories, Murray Hill, NJ, USA, from 1995 to 1997, he contributed to the development of 980-nm high-power semiconductor lasers. He is currently Associate Professor of the Department of Electrical and Computer Engineering at the Pohang University of Science and Technology (POSTECH). He co-founded the Korea THz Forum, and served as the Director of the Center for THz Photonics (1998–2000) and the National Laboratory for Nano-THz Photonics (2005–2009). He invented THz plastic photonic crystal fibers for single-mode THz pulse transmission in 2001. His current research interests include THz hydration dynamics of biomolecules, THz quantum interactions, and THz near-field microscopy and spectroscopy.

Peter Uhd Jepsen (M'10) received the M.Sc. degree in physics and chemistry from Odense University, Denmark, in 1994, and the Ph.D. degree in natural sciences from Århus University, Denmark in 1996.

He was at the University of Freiburg, Germany from 1996 to 2004, working with terahertz time-domain spectroscopy. From 2005 he was Associate Professor at the Technical University of Denmark (DTU), and since 2008 Professor and Head of the Terahertz Technologies and Biophotonics group at DTU. In 2008/2009 he was Visiting Professor at Osaka University. His research areas include photonics-based THz technology, broadband THz spectroscopy for chemical sensing, imaging, chemistry, and water dynamics in the THz range, and time-resolved THz spectroscopy of ultrafast phenomena in the THz range.

Victor M. Lubecke received the B.S.E.E. degree from the California State Polytechnic Institute, Pomona, CA, USA, in 1986, and the M.S. and Ph.D. degrees in electrical engineering from the California Institute of Technology, Pasadena, CA, USA, in 1990 and 1995, respectively.

He is currently a professor of Electrical Engineering at the University of Hawaii, Manoa, HI, USA. From 1998 to 2003, Dr. Lubecke was with Bell Laboratories, Lucent Technologies, where his research focused on remote sensing technologies for biomedical and industrial applications, and on microelectromechanical systems (MEMS) and 3-D wafer-scale integration technologies for wireless and optical communications. From 1987 through 1996, he was with the NASA Jet Propulsion Laboratory (JPL), and from 1996 to 1998, he was with the Institute for Physical and Chemical Research (RIKEN), Sendai, Japan, where his research involved terahertz and MEMS technologies for space remote sensing and communications applications. He holds 6 U.S. patents with several pending, and has published over 150 peer-reviewed research articles.

Prof. Lubecke is an emeritus Distinguished Microwave Lecturer ('06–'08) of the IEEE Microwave Theory and Techniques Society, and was co-recipient of the Emerging Technology Award at TechConnect 2007. He co-founded and served as CTO for a start-up company that is now Kai Medical, Honolulu, HI. His current research interests include remote sensing technologies, biomedical sensors, MEMS, heterogeneous integration, and microwave/terahertz radio.

Kodo Kawase received the B.S. degree in electronic engineering from Kyoto University in 1989, Japan, and the Ph.D. degree in electronic engineering from Tohoku University, Japan, in 1996.

He became an Initiative Researcher at RIKEN in 2001 and a Professor in the Graduate School of Engineering, Nagoya University, Japan, in 2005. He has been conducting research activities in several directions within the THz field. Professor Kawase developed several types of widely tunable THz sources using nonlinear optical effects, and implemented them for a wide range of real-life applications. He has published more than 130 articles in the THz field and has given more than 160 invited talks on this subject.

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University of Delft, Netherlands, where she is a professor in the Electrical Engineering department, and she continues to be an affiliate at JPL, Pasadena. Her research interests include the analysis and design of planar antennas, periodic structures, reflector antennas, lens antennas, waveguide structures, with emphasis in the THz range.

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He is currently Principal Member of Engineering staff at the Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA, and Supervisor of the JPL Submillimeter-Wave advanced Technology (SWAT) team. His responsibilities include developing THz components and subsystems for current and future NASA missions. He joined JPL in 1990 where his first task included the design and fabrication of low-parasitic planar Schottky diodes for submillimeter-wave applications. These devices were implemented on the ozone monitoring Microwave Limb Sounder instrument launched in 2004, as well as the MIRO instrument which represents the first submillimeter-wave receiver that will rendezvous with a comet in 2014. From 1999, he led the effort of developing broadband solid-state sources from 200 to 2500 GHz for the Heterodyne Instrument for Far Infrared (HIFI) on the Herschel Space Observatory, a cornerstone European Space Agency mission currently in space. This effort led to realization of wide-band solid-state sources in the THz range enabling ground-breaking astrophysics observations in space as well as at many ground-based observatories. His current interests include both mm and sub-mm wave devices, semiconductor fabrication technology, high-frequency instrumentation, and heterodyne receivers for miniature systems.

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Editorial

AS YOU BEGIN to enjoy Spring in the northern hemisphere, we are extremely pleased to bring you our promised Special May Issue of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY focused on **Terahertz Spectroscopic Techniques and Applications**.

This is the first *full* Special Issue since our Inaugural publication (Volume 1, Issue 1) that was distributed in September 2011. In this print release, highlighting THz Spectroscopy, we include a combination of seven *Invited* papers and four contributed manuscripts that were specifically flagged for this issue.

Special Issue Guest Editor, **Peter Uhd Jepson** from the Technical University of Denmark and Guest Editor **David Cooke** of McGill University, Canada have worked extremely hard to make sure we have a representative assortment of quality articles and authors to cover our special issue topic. You will find a more detailed description and a summary of the papers, in the brief *Introduction to the Special Issue* that follows our usual opening THz Pioneer article.

In keeping with the theme of the Special Spectroscopy Issue, and in keeping up the novelty of our transactions, our *Terahertz Pioneer* piece is not on one, but on *two* individuals who have had long, continuous, and significant contributions to THz science—**Manfred and Brenda Winnewisser**. They, along with Manfred's well remembered younger brother, **Gisbert Winnewisser**, who sadly passed away in March 2011, represent a true THz Spectroscopy family dynasty that stretches back to the Walter Gordy microwave spectroscopy lab at Duke University, where all three converged, and trained for a time in the mid-1960's. I am certain their story will help inspire you to stay in science and to keep focusing on the THz frequency regime.

I am also very pleased to announce that our TRANSACTIONS articles are now being indexed in Reuter's "Science Citation Index Expanded (SciSearch)," "Journal Citation Reports/Science Edition," and "Current Contents/Engineering, Computing and Technology," starting with Volume 1, Issue 1, September 2011. This means citations and article titles will now appear in *Web of Science* and other popular Reuter's search engines.

A new Special Issue on **THz Metamaterials and Applications** is slated for a late Fall release and our *Call for Papers* can be found in the back of this month's print issue. Please plan to start thinking about a contribution soon, and if we are so honored to receive one, please remember to flag it as an SPI or Special Issue contribution if you would like the paper to be included in our bundled print release.

Finally, we will be publishing papers this summer from our Joint Special Issue with the IEEE JOURNAL OF BIOMEDICAL AND HEALTH INFORMATICS (J-BHI) on **Terahertz Imaging and Spectroscopy for Biology and Biomedicine**. Look for these as a Special Mini Issue that will be part of our July regular print release.

Again, I want to thank you for your continued interest and support of our transactions and I hope you will find Volume 3, Issue 3 of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY a useful source of information and ideas.

Yours sincerely,

PETER H. SIEGEL, *Editor-in-Chief*

Peter H. Siegel (S'77–M'83–SM'98–F'01) received the B.A. degree from Colgate University, Hamilton, NY, in 1976, and the Ph.D. degree from Columbia University, New York, in 1983.

He holds appointments as Faculty Associate in Electrical Engineering and Senior Scientist in Biology at Caltech and Senior Research Scientist at the Jet Propulsion Laboratory (JPL) in Pasadena, CA. He has been working in the areas of millimeter and submillimeter-wave technology and applications for 38 years and has PI'd or co-I'd more than 75 R&D programs and been involved in four major space flight instruments. He has published more than 275 articles in the THz field and has given more than 150 invited talks in the US and abroad on this subject. At JPL, he founded, and led for more than 20 years, the JPL Submillimeter Wave Advanced Technology (SWAT) team, a group of 20+ research scientists and engineers developing THz technology for NASA's near and long term space missions as well as for several DoD applications. At Caltech, Dr. Siegel is involved in new biological and medical applications of THz. His current interests are split between traditional Earth, planetary and astrophysics applications and new THz applications in medicine and biology.

Among many other duties, Dr. Siegel co-chaired and chaired for six years, and is now General Secretary for the International Conference for Infrared, Millimeter and Terahertz Waves (IRMMW-THz), the oldest and largest venue devoted to the field of far IR techniques, science and applications, and he served as conference organizer and chair for IRMMW-THz 2008 in Pasadena. He also set up and administers the International Society of Infrared, Millimeter and Terahertz Waves in 2010, a non-profit organization that is responsible for overseeing the conference series. He has served as an IEEE Distinguished Microwave Lecturer, co-chair and chair of MTT Committee 4-THz Technology, a TPC and Speaker's bureau member, and as organizer and chair of seven sequential special sessions at the IEEE International Microwave Symposia. He is extremely pleased, and very excited to be involved in the formation and launching of the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY. (His Web Pages: http://www.thz.caltech.edu; http://www.irmmw-thz.org; http://www.thz.ieee.org, e-mail: phs@caltech.edu).

ADMINISTRATIVE EDITOR

Sharri Shaw was born in Michigan, and currently resides in Boulder, CO. She received the B.A. degree in english and a minor in psychology, from Saginaw Valley State University, in 1994. She continued her studies in 2001 in the Master in Education with Initial Certification (M.Ed.) program at Aquinas College, where she received her Secondary Level Teacher Certification.

From 2002 to 2005, she was a teacher in Michigan. From 2006 to 2010, she was the Assistant Editor of the IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES. She currently holds the same position with *IEEE Microwave Magazine*, and also serves as the Publications Administrator for the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

Digital Object Identifier 10.1109/TTHZ.2013.2257191

TOPIC EDITORS

René Beigang received the Diploma and Ph.D. degrees from the University of Hannover, Hannover, Germany.

He spent 3 years as a post-doctorate and visiting scientist at the IBM T. J. Watson Research Center, Yorktown Heights, NY. He was Associate Professor at the Free University of Berlin and the University of Kaiserslautern. He is now a full professor at the Department of Physics of the University of Kaiserslautern. Since 2005, he is also Head of the Department on Terahertz Measurement and Systems of the Fraunhofer Institute for Physical Measurement Techniques. His current research interests include nonlinear optics, generation and application of THz radiation, THz spectroscopy, applications of THz radiation in science and technology, realization and investigation of THz meta materials. (His homepage: http://www.physik.uni-kl.de/beigang).

René Beigang received the Diploma and Ph.D. degrees from the University of Hannover, Hannover, Germany.

He spent 3 years as a post-doctorate and visiting scientist at the IBM T. J. Watson Research Center, Yorktown Heights, NY. He was Associate Professor at the Free University of Berlin and the University of Kaiserslautern. He is now a full professor at the Department of Physics of the University of Kaiserslautern. Since 2005, he is also Head of the Department on Terahertz Measurement and Systems of the Fraunhofer Institute for Physical Measurement Techniques. His current research interests include nonlinear optics, generation and application of THz radiation, THz spectroscopy, applications of THz radiation in science and technology, realization and investigation of THz meta materials. (His homepage: http://www.physik.uni-kl.de/beigang).

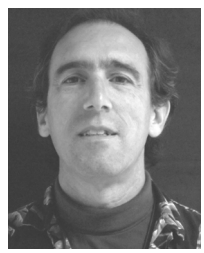
A. Giles Davies received the B.Sc. degree in chemical physics from the University of Bristol, Bristol, U.K., in 1987, and the Ph.D. degree in semiconductor physics from the University of Cambridge, Cambridge, U.K., in 1991.

He is currently Professor of Electronic and Photonic Engineering at the University of Leeds, Leeds, U.K. His research interests concentrate on the electrical and optical properties of low- dimensional and nanostructured electronic systems, and multilayered semiconductor devices, with particular recent focus on the development of terahertz frequency systems and the exploitation of biological processes for nanoscale assembly.

Gian Piero Gallerano received the Laurea Degree (Ph.D.) in physics from the University of Rome, Italy in 1980 with a thesis on the realization of a tunable color center laser in the near infrared.

In 1981, he was a Visiting Fellow at the Technical University Hannover, Germany. In 1983 he joined the High Power Laser Laboratory at ENEA Research Center, Frascati to work on the development of infrared free electron lasers (FEL). In 1991 he was a Visiting Scholar at the Ginzton Laboratory, EE Dept, Stanford University. His work on FELs lead to the realization of the ENEA Compact FEL (90–150 GHz) and of the Compact Advanced THz Source, FEL-CATS (0.4–0.7 THz). From 2001 to 2004 he has been the Coordinator of the European project THz-BRIDGE involving ten research institutes in the study the interaction of THz radiation with biological systems. From 2005 to 2007, he was in charge of the ENEA participation in the European project EUROFEL. He is currently the Head of the Radiation Sources Laboratory at ENEA Frascati. His areas of interest include generation of THz radiation and its application in the biological, biomedical, environmental and art conservation fields, THz imaging techniques, coherent emission from RF modulated electron beams, free electron lasers, optical design and diagnostics in the infrared.

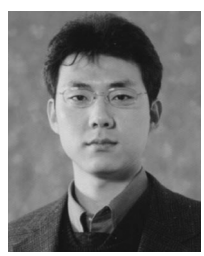
Dr. Gallerano organized the "35th International Conference on Infrared, Millimeter and THz Waves" IRMMW-THz 2010 held in Rome, Italy, September 5–10, 2010., and currently chairs the International Society of Infrared, Millimeter and Terahertz Waves, the oldest and largest forum devoted to scientific and technological developments in the wide spectral range extending from the infrared to the millimeter wave region. He has been a member of the Italian Physical Society since 1981, and is a member of the Bioelectromagnetics Society.



Erich N. Grossman received the A.B. degree in physics from Harvard College, Cambridge, MA, in 1980, and a Ph.D. degree, also in physics, from the California Institute of Technology, Pasadena, in 1987. His thesis work involved development of an ultra-low noise, heterodyne receiver for 2 THz astronomy.

From 1988 to 1989, he was a post-doctoral fellow at the University of Texas at Austin, TX, USA, and in 1989, he joined the National Institute of Standards and Technology, Boulder, CO, USA, where he is now a physicist in the Optoelectronics Division. His work at NIST focuses on infrared and submillimeter system development.

Dr. Grossman's notable accomplishments include the development and demonstration of the world's highest frequency, high efficiency lithographic antennas, the world's highest frequency Josephson junctions, (awarded a Department of Commerce Gold Medal in 1993), and early conception and development of the SQUID multiplexer, first enabling large monolithic arrays of superconducting detectors. More recently, he has developed several 0.1–1 THz cameras for security applications. He is also chair of the Metrology Working Group for the DARPA Terahertz Electronics program.



Haewook Han (M'12) received the B.S. and M.S. degrees in electrical engineering from Seoul National University, Seoul, Korea, in 1986 and 1988, respectively, and the Ph.D. degree in electrical engineering from the University of Illinois at Urbana-Champaign, Urbana, IL, USA, in 1995.

He studied low-threshold strained quantum-well heterostructure lasers and two-dimensional photonic crystal semiconductor lasers. At Bell Laboratories, Murray Hill, NJ, USA, from 1995 to 1997, he contributed to the development of 980-nm high-power semiconductor lasers. He is currently Associate Professor of the Department of Electrical and Computer Engineering at the Pohang University of Science and Technology (POSTECH). He co-founded the Korea THz Forum, and served as the Director of the Center for THz Photonics (1998–2000) and the National Laboratory for Nano-THz Photonics (2005–2009). He invented THz plastic photonic crystal fibers for single-mode THz pulse transmission in 2001. His current research interests include THz hydration dynamics of biomolecules, THz quantum interactions, and THz near-field microscopy and spectroscopy.

Peter Uhd Jepsen (M'10) received the M.Sc. degree in physics and chemistry from Odense University, Denmark, in 1994, and the Ph.D. degree in natural sciences from Århus University, Denmark in 1996.

He was at the University of Freiburg, Germany from 1996 to 2004, working with terahertz time-domain spectroscopy. From 2005 he was Associate Professor at the Technical University of Denmark (DTU), and since 2008 Professor and Head of the Terahertz Technologies and Biophotonics group at DTU. In 2008/2009 he was Visiting Professor at Osaka University. His research areas include photonics-based THz technology, broadband THz spectroscopy for chemical sensing, imaging, chemistry, and water dynamics in the THz range, and time-resolved THz spectroscopy of ultrafast phenomena in the THz range.

Victor M. Lubecke received the B.S.E.E. degree from the California State Polytechnic Institute, Pomona, CA, USA, in 1986, and the M.S. and Ph.D. degrees in electrical engineering from the California Institute of Technology, Pasadena, CA, USA, in 1990 and 1995, respectively.

He is currently a professor of Electrical Engineering at the University of Hawaii, Manoa, HI, USA. From 1998 to 2003, Dr. Lubecke was with Bell Laboratories, Lucent Technologies, where his research focused on remote sensing technologies for biomedical and industrial applications, and on microelectromechanical systems (MEMS) and 3-D wafer-scale integration technologies for wireless and optical communications. From 1987 through 1996, he was with the NASA Jet Propulsion Laboratory (JPL), and from 1996 to 1998, he was with the Institute for Physical and Chemical Research (RIKEN), Sendai, Japan, where his research involved terahertz and MEMS technologies for space remote sensing and communications applications. He holds 6 U.S. patents with several pending, and has published over 150 peer-reviewed research articles.

Prof. Lubecke is an emeritus Distinguished Microwave Lecturer (2006–2008) of the IEEE Microwave Theory and Techniques Society, and was co-recipient of the Emerging Technology Award at TechConnect 2007. He co-founded and served as CTO for a start-up company that is now Kai Medical, Honolulu, HI. His current research interests include remote sensing technologies, biomedical sensors, MEMS, heterogeneous integration, and microwave/terahertz radio.

Kodo Kawase received the B.S. degree in electronic engineering from Kyoto University in 1989, Japan, and the Ph.D. degree in electronic engineering from Tohoku University, Japan, in 1996.

He became an Initiative Researcher at RIKEN in 2001 and a Professor in the Graduate School of Engineering, Nagoya University, Japan, in 2005. He has been conducting research activities in several directions within the THz field. Professor Kawase developed several types of widely tunable THz sources using nonlinear optical effects, and implemented them for a wide range of real-life applications. He has published more than 130 articles in the THz field and has given more than 160 invited talks on this subject.

Dr. Kawase received the 1997 Young Scientist Award from the JSAP, the 1998 Excellent Presentation Award, the 2000 and 2006 Prize of Laser Engineering from the Laser Society of Japan, the 2002 Marubun research and encouragement award and the 2006 Marubun Special Research Award from the Marubun Research Promotion Foundation (MRPF), and the 2005 Young Scientists' Prize by the Commendation for Science and Technology of the Minister of Education, Culture, Science and Technology (MEXT).

Nuria Llombart received the Electrical Engineering degree and Ph.D. degree from the Polytechnic University of Valencia, Spain, in 2002 and 2006, respectively.

During her Masters' degree studies she spent one year at the Friedrich-Alexander University of Erlangen-Nuremberg, Germany, and worked at the Fraunhofer Institute for Integrated Circuits, Erlangen, Germany. From 2002 until 2007, she was with the Antenna Group at the TNO Defence, Security and Safety Institute, The Hague, The Netherlands, working as Ph.D. student and afterwards as a researcher. From 2007 until 2010, she was a Post-Doctoral Fellow at the California Institute of Technology, working for the Sub millimeter Wave Advance Technology group of the Jet Propulsion Laboratory (JPL), Pasadena, CA, USA. From 2010 to 2012, she held a "Ramón y Cajal" fellowship at the Optics Department of the Complutense University of Madrid, Spain. She recently relocated to Technical University of Delft, Netherlands, where she is a professor in the Electrical Engineering department, and she continues to be an affiliate at JPL, Pasadena. Her research interests include the analysis and design of planar antennas, periodic structures, reflector antennas, lens antennas, waveguide structures, with emphasis in the THz range.

Dr. Llombart was co-recipient of the H. A. Wheeler Award for the Best Applications Paper of 2008 in the IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION. She was also a co-recipient of an Honorable Mention at the 2010 European Conference of Antennas.

Imran Mehdi (S'83–M'90–SM'09–F'10) received the B.S.E.E. degree in 1985, the M.S.E.E. degree in 1986, and the Ph.D. degree in 1990, all from the University of Michigan.

He is currently Principal Member of Engineering staff at the Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA, and Supervisor of the JPL Submillimeter-Wave advanced Technology (SWAT) team. His responsibilities include developing THz components and subsystems for current and future NASA missions. He joined JPL in 1990 where his first task included the design and fabrication of low-parasitic planar Schottky diodes for submillimeter-wave applications. These devices were implemented on the ozone monitoring Microwave Limb Sounder instrument launched in 2004, as well as the MIRO instrument which represents the first submillimeter-wave receiver that will rendezvous with a comet in 2014. From 1999, he led the effort of developing broadband solid-state sources from 200 to 2500 GHz for the Heterodyne Instrument for Far Infrared (HIFI) on the Herschel Space Observatory, a cornerstone European Space Agency mission currently in space. This effort led to realization of wide-band solid-state sources in the THz range enabling ground-breaking astrophysics observations in space as well as at many ground-based observatories. His current interests include both mm and sub-mm wave devices, semiconductor fabrication technology, high-frequency instrumentation, and heterodyne receivers for miniature systems.

Jan Stake (M'95) received the M.Sc. degree in electrical engineering and Ph.D. degree in microwave electronics from Chalmers University of Technology, Göteborg, Sweden, in 1994 and 1999, respectively.

In 1997, he was a Research Assistant at the University of Virginia, Charlottesville, VA, USA. From 1999 to 2001, he was a Research Fellow in the millimeter wave group at the Rutherford Appleton Laboratory, U.K. He then joined Saab Combitech Systems AB as a Senior RF/microwave Engineer until 2003. From 2000 to 2006, he held different academic positions at Chalmers and was also Head of the Nanofabrication Laboratory at MC2 between 2003 and 2006. During 2007, he was a Visiting Professor in the Submillimeter Wave Advanced Technology (SWAT) group at Caltech/JPL, exploring THz applications in biology and medicine. He is currently Professor and Head of the Terahertz and Millimetre Wave Laboratory, Chalmers, Switzerland. His research involves terahertz sources, detectors and mixers, high frequency semiconductor devices, graphene electronics, terahertz measurement techniques and applications.

Christopher Walker has over 25 years experience designing, building, and using state-of-the-art receiver systems for THz astronomy. He is a Professor of Astronomy and an Associate Professor of Optical Sciences and Electrical Engineering at the University of Arizona (U of A). He has worked in industry (TRW Aerospace and JPL) as well as academia. As a Millikan Fellow in Physics at Caltech, he worked on the development of low-noise, SIS waveguide receivers above 400 GHz and explored techniques for etching waveguide out of silicon. On joining the U of A faculty in 1991 he began the Steward Observatory Radio Astronomy Lab (SORAL), which has become a world leader in developing THz receiver systems for astronomy and other remote sensing applications. These instruments are multi-institutional efforts, with key components coming from JPL, several universities, and a number of industrial partners. He manages and coordinates these efforts. Instruments developed by Prof. Walker's team have served as primary facility instruments at the Heinrich Hertz Telescope on Mt. Graham, AZ, USA, and the AST/RO telescope at the South Pole. He is leading the effort to design and build the world's largest (64 pixels) submillimeter-wave heterodyne array receiver (SuperCam). He is also PI of the NASA funded long duration balloon project "The Stratospheric THz Observatory (STO)". He has published numerous papers on star formation and protostellar evolution. He has served as dissertation director for nine Ph.D. students.

Editorial

THERE are several firsts to report in this, our 12th issue of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

As a start we would like to announce the winners of the 2011/2012 THz Best Paper prize which goes to Philip W. C. Hon, *Student Member, IEEE*, Amir A. Tavallaee, *Student Member, IEEE*, Qi-Sheng Chen, Benjamin S. Williams, *Senior Member, IEEE*, and Tatsuo Itoh, *Life Fellow, IEEE*, for their paper titled, "*Radiation Model for Terahertz Transmission-Line Metamaterial Quantum-Cascade Lasers*," Volume 2, Issue 3, May 2012, pp. 323–332. The recipients were selected by a committee of broad-based THz experts, through a nomination process that is an integral part of our Manuscript Review sequence and liberally supplemented by our Topic Editors. Heartfelt congratulations to this year's winners!

Next year's THz Best Paper prize will cover the six print issues in 2013. Nominations are due directly after the release of Volume 3, Issue 6, expected to be mailed out in mid November, 2013. You are welcome to send your nomination directly to the Editor-in-Chief at any time (*phs@caltech.edu*), listing the selected paper, and accompanied by a short write-up explaining why you think the article merits the prize. All nominations will be considered by the prize committee.

This month, in the first part of our print edition, we bring you our Joint Special Issue with the IEEE JOURNAL OF BIOMEDICAL AND HEALTH INFORMATICS (J-BHI) on **Terahertz Imaging and Spectroscopy for Biology and Biomedicine**. The Mini-Special Issue consists of seven contributed papers and an Introduction by Special Issue Editor-in-Chief, Professor Emma MacPherson. Professor MacPherson was assisted by our own THz Transactions Topic Editors, Gian Piero Gallerano and Gun-Sik Park, as well as by Guest Editors, Henning Hintzsche and Gerald Wilmink. The papers in this Mini-Special Issue are also being released in the July 2013 issue of J-BHI.

For those of you who follow our THz Pioneer series, we are pleased to highlight an individual this month, who has not only been involved with the THz community since its first well-recognized international conference at the Polytechnic Institute of Brooklyn, NY, USA, in 1970, but who I believe, can lay claim to originating the very first commercial instrument tailored exclusively for the THz community—the *AB Millimetre vector network analyzer*—which reached 400 GHz in 1989 and 1 THz in 1993. I hope **Philippe Goy's** unique engineering contributions to basic physics, and his devotion to RF measurements, will inspire more people to blend their science interests and their fabrication skills. This will most certainly result in many more THz components and instruments reaching the community, and thereby spur additional applications.

Following our Mini-Special Issue, we have a large number of contributed papers to share with you this month. These include three papers held over from our January issue that cover topics from the *2012 International Symposium on Space Terahertz Technology*. Two are from the Chalmers group in Sweden, Bevilacqua *et al.* on hot electron-bolometer mixers, and Billade *et al.* on W-band superconducting–insulator–superconducting (SIS) mixers with noise temperature reaching the quantum limit. The third ISSTT paper is from the National Astronomical Observatory of Japan, Hibi *et al.*, on an SIS detector-based camera. A fourth astrophysics instrumentation paper was contributed by Tong *et al.* from the Harvard Smithsonian Astrophysical Observatory, on wideband mixers using SIS junction arrays.

NIST Boulder and Teledyne Scientific team up to present a technique for characterizing microstrip-embedded transistors up to 750 GHz in Williams, Young, and Urteaga. This is followed by a paper from Komandin *et al.* at Moscow State University, on a precise system to measure broad band dielectric permittivity using backward wave oscillators at submillimeter-wave frequencies.

The NTT group (Song *et al.*) at Microsystem Integration Labs, Kanagawa, Japan, reports on a fully integrated 300 GHz communications receiver package with a demonstrated 24 Gbit/s error-free data transmission. High speed data transmission is also demonstrated in a chip-to-chip two-wire interconnect by Jo, Jeon, and Grischkowsky, who sent undistorted optical pulses over distances of 2 m.

Researchers from Carlos III University in Madrid, Spain, Erlangen, Germany, and University of California, Santa Barbara, CA, USA, developed an optically pumped photomixer-based frequency comb generator for producing highly stable, narrow band CW RF signals between 60 and 140 GHz with the promise of scaling to THz frequencies in Criado *et al.* The paper that follows, from groups in Paris, Grenoble, Wurzburg, and Copenhagen (Mariani *et al.*) describe their design for THz generation by difference frequency generation between optically excited whispering gallery mode micro-ring resonators, and present measurements on THz reflectivity.

Saha *et al.* from University of Glasgow, U.K., have used silicon micromachining to fabricate high performance "flat" multilevel diffractive lenses operating above 2.5 THz. Portland State, USA, researchers Henry, Zurk, and Schecklman use correlation processing techniques for suppressing clutter in vector reflection measurements of samples at THz frequencies to help in identification through spectral differencing.

Our last paper from Paul Cunningham at Naval Research Labs, USA, explores charge carrier dynamics through precise measurements of the conductivity change induced from an optical pump and measured using time resolved THz spectroscopy.

Coming up in September, we already have a full issue of papers covering topics from new THz leaky wave antennas to THz biological safety thresholds to THz plasmonic transistors and more. Our *THz Pioneer* feature is on biophysicist and IR and THz scattering near field microscopy originator, Fritz Keilmann, who, at age 71, just finished setting up his new lab at his-

Digital Object Identifier 10.1109/TTHZ.2013.2263385

toric Ludwig Maximilian University, Munich, Germany. I am certain you will find Fritz's story inspiring.

The November print issue will be devoted to **THz Metamaterials and Applications**, including a THz Pioneer interview with *Sir John Pendry*. We are doing our best to make sure you will not find it *metaphysical*.

As mentioned in our last issue, these TRANSACTIONS are now indexed on Web of Science and other Reuter's search engines, so paper visibility is on the rise. Our team has also been working to improve our author experience by adding some requested modifications to our manuscript submission process, and an easy feedback channel to the Editor-in-Chief as you submit your final manuscript files or when you visit our web site at http://thz.ieee.org.

I would also like to extend a personal invitation to any and all of our editorial and review board members who plan to attend the 38th International Conference on Infrared, Millimeter, and Terahertz Waves to be held in Mainz, Germany, between September 1–6, 2013, to join me at a reception in *your* honor during the conference. Invitations will go out in August and an RSVP will be placed on our web site at the same time. I hope to see you there.

As always, I want to thank you for your continued support of our transactions and I really do hope you will find Volume 3, Issue 4 of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY a useful source of information and ideas.

Yours sincerely,

PETER H. SIEGEL, *Editor-in-Chief*

Editorial

IT IS HARD to believe that we are starting our third season of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY with this release of issue number 13 of our print volumes.

Many of you will have already noticed that the journal is now being indexed on Web of Science, and at last check, postings were only one issue behind calendar release dates. Our paper queue is now quite respectable, and as a consequence the next several print issues will be much thicker than usual. Although we will remain on a bi-monthly print release schedule for 2014, you may need to set aside some extra space on your shelf if you are holding on to this, and future volumes.

This September 2013 issue consists only of regular manuscript submissions, but these cover a very wide range of topics, authors, and geographic regions. I will let the Table of Contents speak for itself this month, rather than pointing out individual papers. I will mention, however, that the subject of our ***THz Pioneer*** article, *Dr. Fritz Keilmann*, has some very interesting lessons for us and a very colorful history, that should prove enlightening, even for those of us who have had the honor of calling him *friend*.

I would again like to remind authors to please take advantage of the *Editor-in-Chief feedback box* that now appears with the final manuscript upload process, and to note that you may also contact the IEEE MTT-S Publications chair directly at: PublicationsChair@mtt.org if you wish to send confidential information about the paper submission process, or any subject involving this publication, to an independent third party.

Next month (November 2013 issue) we will be releasing our Special Issue on **THz Metamaterials and Applications** and we will announce the name of our first "*Exceptional Reviewer*" award winner. January 2014 will spearhead Volume 4, with our Mini-Special Issue highlighting full papers from the *2013 International Symposium on Space Terahertz Technology*, as well as continued regular submitted manuscripts.

As always, I want to thank our team of Topic Editors, our loyal and accommodating Review Board Members, and *you*, our contributors and subscribers, who have contributed to the growing success of our humble publication. Please continue on to read Volume 3, Issue 5 of our IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

Yours sincerely,

PETER H. SIEGEL, *Editor-in-Chief*

Digital Object Identifier 10.1109/TTHZ.2013.2275914

Peter H. Siegel (S'77–M'83–SM'98–F'01) received the B.A. degree from Colgate University, Hamilton, NY, in 1976, and the Ph.D. degree from Columbia University, New York, in 1983.

He holds appointments as Faculty Associate in Electrical Engineering and Senior Scientist in Biology at Caltech and Senior Research Scientist at the Jet Propulsion Laboratory (JPL) in Pasadena, CA. He has been working in the areas of millimeter and submillimeter-wave technology and applications for 38 years and has PI'd or co-I'd more than 75 R&D programs and been involved in four major space flight instruments. He has published more than 275 articles in the THz field and has given more than 150 invited talks in the US and abroad on this subject. At JPL, he founded, and led for more than 20 years, the JPL Submillimeter Wave Advanced Technology (SWAT) team, a group of 20+ research scientists and engineers developing THz technology for NASA's near and long term space missions as well as for several DoD applications. At Caltech, Dr. Siegel is involved in new biological and medical applications of THz. His current interests are split between traditional Earth, planetary and astrophysics applications and new THz applications in medicine and biology.

Among many other duties, Dr. Siegel co-chaired and chaired for six years, and is now General Secretary for the International Conference for Infrared, Millimeter and Terahertz Waves (IRMMW-THz), the oldest and largest venue devoted to the field of far IR techniques, science and applications, and he served as conference organizer and chair for IRMMW-THz 2008 in Pasadena. He also set up and administers the International Society of Infrared, Millimeter and Terahertz Waves in 2010, a non-profit organization that is responsible for overseeing the conference series. He has served as an IEEE Distinguished Microwave Lecturer, co-chair and chair of MTT Committee 4-THz Technology, a TPC and Speaker's bureau member, and as organizer and chair of seven sequential special sessions at the IEEE International Microwave Symposia. He is extremely pleased, and very excited to be involved in the formation and launching of the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY. (His Web Pages: http://www.thz.caltech.edu; http://www.irmmw-thz.org; http://www.thz.ieee.org, e-mail: phs@caltech.edu).

ADMINISTRATIVE EDITOR

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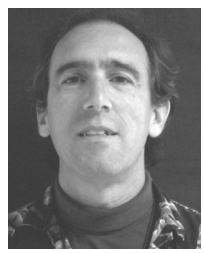

Erich N. Grossman received the A.B. degree in physics from Harvard College, Cambridge, MA, in 1980, and a Ph.D. degree, also in physics, from the California Institute of Technology, Pasadena, in 1987. His thesis work involved development of an ultra-low noise, heterodyne receiver for 2 THz astronomy.

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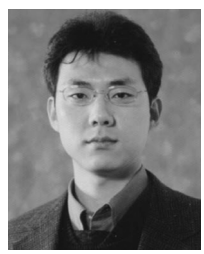
Dr. Grossman's notable accomplishments include the development and demonstration of the world's highest frequency, high efficiency lithographic antennas, the world's highest frequency Josephson junctions, (awarded a Department of Commerce Gold Medal in 1993), and early conception and development of the SQUID multiplexer, first enabling large monolithic arrays of superconducting detectors. More recently, he has developed several 0.1–1 THz cameras for security applications. He is also chair of the Metrology Working Group for the DARPA Terahertz Electronics program.



Haewook Han (M'12) received the B.S. and M.S. degrees in electrical engineering from Seoul National University, Seoul, Korea, in 1986 and 1988, respectively, and the Ph.D. degree in electrical engineering from the University of Illinois at Urbana-Champaign, Urbana, IL, USA, in 1995.

He studied low-threshold strained quantum-well heterostructure lasers and two-dimensional photonic crystal semiconductor lasers. At Bell Laboratories, Murray Hill, NJ, USA, from 1995 to 1997, he contributed to the development of 980-nm high-power semiconductor lasers. He is currently Associate Professor of the Department of Electrical and Computer Engineering at the Pohang University of Science and Technology (POSTECH). He co-founded the Korea THz Forum, and served as the Director of the Center for THz Photonics (1998–2000) and the National Laboratory for Nano-THz Photonics (2005–2009). He invented THz plastic photonic crystal fibers for single-mode THz pulse transmission in 2001. His current research interests include THz hydration dynamics of biomolecules, THz quantum interactions, and THz near-field microscopy and spectroscopy.

Peter Uhd Jepsen (M'10) received the M.Sc. degree in physics and chemistry from Odense University, Denmark, in 1994, and the Ph.D. degree in natural sciences from Århus University, Denmark in 1996.

He was at the University of Freiburg, Germany from 1996 to 2004, working with terahertz time-domain spectroscopy. From 2005 he was Associate Professor at the Technical University of Denmark (DTU), and since 2008 Professor and Head of the Terahertz Technologies and Biophotonics group at DTU. In 2008/2009 he was Visiting Professor at Osaka University. His research areas include photonics-based THz technology, broadband THz spectroscopy for chemical sensing, imaging, chemistry, and water dynamics in the THz range, and time-resolved THz spectroscopy of ultrafast phenomena in the THz range.

Kodo Kawase received the B.S. degree in electronic engineering from Kyoto University in 1989, Japan, and the Ph.D. degree in electronic engineering from Tohoku University, Japan, in 1996.

He became an Initiative Researcher at RIKEN in 2001 and a Professor in the Graduate School of Engineering, Nagoya University, Japan, in 2005. He has been conducting research activities in several directions within the THz field. Professor Kawase developed several types of widely tunable THz sources using nonlinear optical effects, and implemented them for a wide range of real-life applications. He has published more than 130 articles in the THz field and has given more than 160 invited talks on this subject.

Dr. Kawase received the 1997 Young Scientist Award from the JSAP, the 1998 Excellent Presentation Award, the 2000 and 2006 Prize of Laser Engineering from the Laser Society of Japan, the 2002 Marubun research and encouragement award and the 2006 Marubun Special Research Award from the Marubun Research Promotion Foundation (MRPF), and the 2005 Young Scientists' Prize by the Commendation for Science and Technology of the Minister of Education, Culture, Science and Technology (MEXT).

Nuria Llombart received the Electrical Engineering degree and Ph.D. degree from the Polytechnic University of Valencia, Spain, in 2002 and 2006, respectively.

During her Masters' degree studies she spent one year at the Friedrich-Alexander University of Erlangen-Nuremberg, Germany, and worked at the Fraunhofer Institute for Integrated Circuits, Erlangen, Germany. From 2002 until 2007, she was with the Antenna Group at the TNO Defence, Security and Safety Institute, The Hague, The Netherlands, working as Ph.D. student and afterwards as a researcher. From 2007 until 2010, she was a Post-Doctoral Fellow at the California Institute of Technology, working for the Sub millimeter Wave Advance Technology group of the Jet Propulsion Laboratory (JPL), Pasadena, CA, USA. From 2010 to 2012, she held a "Ramón y Cajal" fellowship at the Optics Department of the Complutense University of Madrid, Spain. She recently relocated to Technical University of Delft, Netherlands, where she is a professor in the Electrical Engineering department, and she continues to be an affiliate at JPL, Pasadena. Her research interests include the analysis and design of planar antennas, periodic structures, reflector antennas, lens antennas, waveguide structures, with emphasis in the THz range.

Dr. Llombart was co-recipient of the H. A. Wheeler Award for the Best Applications Paper of 2008 in the IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION. She was also a co-recipient of an Honorable Mention at the 2010 European Conference of Antennas.

Victor M. Lubecke received the B.S.E.E. degree from the California State Polytechnic Institute, Pomona, CA, USA, in 1986, and the M.S. and Ph.D. degrees in electrical engineering from the California Institute of Technology, Pasadena, CA, USA, in 1990 and 1995, respectively.

He is currently a professor of Electrical Engineering at the University of Hawaii, Manoa, HI, USA. From 1998 to 2003, Dr. Lubecke was with Bell Laboratories, Lucent Technologies, where his research focused on remote sensing technologies for biomedical and industrial applications, and on microelectromechanical systems (MEMS) and 3-D wafer-scale integration technologies for wireless and optical communications. From 1987 through 1996, he was with the NASA Jet Propulsion Laboratory (JPL), and from 1996 to 1998, he was with the Institute for Physical and Chemical Research (RIKEN), Sendai, Japan, where his research involved terahertz and MEMS technologies for space remote sensing and communications applications. He holds 6 U.S. patents with several pending, and has published over 150 peer-reviewed research articles.

Prof. Lubecke is an emeritus Distinguished Microwave Lecturer (2006–2008) of the IEEE Microwave Theory and Techniques Society, and was co-recipient of the Emerging Technology Award at TechConnect 2007. He co-founded and served as CTO for a start-up company that is now Kai Medical, Honolulu, HI. His current research interests include remote sensing technologies, biomedical sensors, MEMS, heterogeneous integration, and microwave/terahertz radio.

Imran Mehdi (S'83–M'90–SM'09–F'10) received the B.S.E.E. degree in 1985, the M.S.E.E. degree in 1986, and the Ph.D. degree in 1990, all from the University of Michigan.

He is currently Principal Member of Engineering staff at the Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA, and Supervisor of the JPL Submillimeter-Wave advanced Technology (SWAT) team. His responsibilities include developing THz components and subsystems for current and future NASA missions. He joined JPL in 1990 where his first task included the design and fabrication of low-parasitic planar Schottky diodes for submillimeter-wave applications. These devices were implemented on the ozone monitoring Microwave Limb Sounder instrument launched in 2004, as well as the MIRO instrument which represents the first submillimeter-wave receiver that will rendezvous with a comet in 2014. From 1999, he led the effort of developing broadband solid-state sources from 200 to 2500 GHz for the Heterodyne Instrument for Far Infrared (HIFI) on the Herschel Space Observatory, a cornerstone European Space Agency mission currently in space. This effort led to realization of wide-band solid-state sources in the THz range enabling ground-breaking astrophysics observations in space as well as at many ground-based observatories. His current interests include both mm and sub-mm wave devices, semiconductor fabrication technology, high-frequency instrumentation, and heterodyne receivers for miniature systems.

Jan Stake (M'95) received the M.Sc. degree in electrical engineering and Ph.D. degree in microwave electronics from Chalmers University of Technology, Göteborg, Sweden, in 1994 and 1999, respectively.

In 1997, he was a Research Assistant at the University of Virginia, Charlottesville, VA, USA. From 1999 to 2001, he was a Research Fellow in the millimeter wave group at the Rutherford Appleton Laboratory, U.K. He then joined Saab Combitech Systems AB as a Senior RF/microwave Engineer until 2003. From 2000 to 2006, he held different academic positions at Chalmers and was also Head of the Nanofabrication Laboratory at MC2 between 2003 and 2006. During 2007, he was a Visiting Professor in the Submillimeter Wave Advanced Technology (SWAT) group at Caltech/JPL, exploring THz applications in biology and medicine. He is currently Professor and Head of the Terahertz and Millimetre Wave Laboratory, Chalmers, Switzerland. His research involves terahertz sources, detectors and mixers, high frequency semiconductor devices, graphene electronics, terahertz measurement techniques and applications.

Christopher Walker has over 25 years experience designing, building, and using state-of-the-art receiver systems for THz astronomy. He is a Professor of Astronomy and an Associate Professor of Optical Sciences and Electrical Engineering at the University of Arizona (U of A). He has worked in industry (TRW Aerospace and JPL) as well as academia. As a Millikan Fellow in Physics at Caltech, he worked on the development of low-noise, SIS waveguide receivers above 400 GHz and explored techniques for etching waveguide out of silicon. On joining the U of A faculty in 1991 he began the Steward Observatory Radio Astronomy Lab (SORAL), which has become a world leader in developing THz receiver systems for astronomy and other remote sensing applications. These instruments are multi-institutional efforts, with key components coming from JPL, several universities, and a number of industrial partners. He manages and coordinates these efforts. Instruments developed by Prof. Walker's team have served as primary facility instruments at the Heinrich Hertz Telescope on Mt. Graham, AZ, USA, and the AST/RO telescope at the South Pole. He is leading the effort to design and build the world's largest (64 pixels) submillimeter-wave heterodyne array receiver (SuperCam). He is also PI of the NASA funded long duration balloon project "The Stratospheric THz Observatory (STO)". He has published numerous papers on star formation and protostellar evolution. He has served as dissertation director for nine Ph.D. students.

Editorial

THIS is our last issue of 2013, and I am happy to report that it is our promised *Special Issue on Terahertz Metamaterials and Applications*. I am pleased, because it contains both regular and *Invited* contributions from some of the best known researchers in this bourgeoning field, and also because we successfully overcame many significant hurdles to bring you this issue on, or at least close to, schedule. Our *Special Issue Guest Editors*, Tahsin Akalin, Willie Padilla, Marco Rahm, and especially our own Rene Beigang, went beyond the usual stress level associated with a task of this sort, and deserve our heartfelt appreciation and thanks. Before we plunge into the Special Issue papers however, there are a few other individuals that deserve our appreciation as well as some items of general interest I would like to relay.

First, I want to bring attention to the unsung heroes of our, *and all*, technical journals: *the reviewers*. We celebrated our own hard working, and often under-appreciated, reviewers, this past September with our first IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY *Outstanding Reviewer* award. After a thorough vetting and voting by our Topic Editors, we are pleased to announce two distinguished nominees who shared the top honor. They are University of Massachusetts Lowell Professor, Robert Giles, for the most solicited and most responsive of all of our many reviewers, and recently graduated Ph.D. student; and now staff member at Spain's Universitat Politecnica de Catalunya (UPC), Dr. Maria Alonso del Pino, for a review that not only ranked as the most thorough, but was also one of the most the helpful to the authors. Both our winners received certificates from the IEEE Microwave Theory and Techniques Society, and invitations to a luncheon and reception partially in their honor, at the 2013 International Conference on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2013), held September 2–6, 2013, in Mainz, Germany. We intend to continue to offer this award next year, and encourage all our reviewers to go above and beyond, in helping your colleagues, our journal, and the THz community as a whole, to publish the best papers that can be produced.

Before we finish with the subject of reviewers, I would like to mention that we held our second *Reviewer's Appreciation Reception* at the IRMMW-THz 2013 conference. I had the privilege of welcoming and meeting our room limit of 100 past, present and hopefully future review board members for this IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY. As I stated at the reception, I strongly encourage all graduate students to participate in the review process, with the consent and oversight of their graduate advisors, of course. I believe that this is both a great learning process, and an experience that prepares one well when the *shoe is on the other foot*. With the growing profusion of journals, and the ever-mounting number of technical manuscripts they bring to our attention, there seems to me to be no better way to keep up a strong peer review system than expanding the pool to this group of motivated and avid young professionals. If you are interested in joining our *Review Board*, do not hesitate to send me a note (phs@caltech.edu) with your name, affiliation, and area of expertise. We will be happy to welcome you to our team.

We also held our first *Topic Editor's luncheon* at IRMMW-THz 2013, where we paid tribute to those TEs that retired from active duty in 2013. They received both a hearty thanks and a handsome plaque from the IEEE MTT Society. I would like to again thank them here publicly, and acknowledge their exceptional contributions in helping to start this TRANSACTIONS a full year before the release of our Inaugural Issue in September 2011. They are: Professor Martin Koch, Professor Gun-Sik Park, Professor Jack East, and Dr. Dylan Williams, our former Executive Editor.

The *Topic Editor's luncheon* yielded two new initiatives for this TRANSACTIONS in 2014. One of these I will mention now, as it was also heavily endorsed by a straw poll at the *Reviewer's Reception*. Starting in January 2014, we will include with each print issue of our transactions, a section of short papers under the designation *THz Letters*, that will appear after our regular full length papers. These short papers will undergo the same review process and have the same acceptance standards as our regular manuscripts, but will likely cycle through review a bit faster (*no promises on this as yet, however*). As a result they may appear on IEEEXplore® as non-paginated, but citable papers somewhat further in advance of the print issue to which they are attached, than the remaining full length submissions. If you have been hesitating with a submission to our THz Transactions because of the desire to submit a more concise manuscript, this is your opportunity. Try us out and we will evaluate the community response before setting up a permanent editorial policy.

On another *short* topic, I want to mention that we are accepting nominations for our IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY *Best Paper Award* for January–December 2013. We are hoping to have a final selection process complete before the Winter MTT-S Administrative Committee meeting in mid-January 2014. If you have a particular paper you think deserves to be considered, please send the title and issue number to me, and include a short description of why you believe the paper should be nominated. Please highlight the originality, impact to the community and technical quality of the nomination. All nominations and nominees will be held in strictest confidence within the awards committee.

Looking forward, January 2014 starts off our third full production year. We have a fair number of submissions making their way through final review, and along with a large number of regular submissions, we promise you a nice thick issue to display, if you are so inclined. We have a fair number of submissions making their way through final review, and along with a large number of regular submissions, we promise you a nice thick issue to display, if you are so inclined. The year, 2014, also

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marks the end of our free subscriptions, and from this point forward you will have to get your transactions paper copies through the IEEE membership process or at your local technical library. If you are missing a particular print issue, I do have a few extra copies of all of our prior volumes, and am happy to respond to reasonable requests for back issues.

Finally, I would like to remind authors to please take advantage of the *Editor-in-Chief feedback box* that now appears in the final steps of the manuscript upload process (I am still waiting for my first comments, good or bad!). Note that you may also contact the IEEE MTT-S Publications chair directly at: PublicationsChair@mtt.org if you wish to send confidential information about the paper submission process, the Editor-in-Chief, or any subject involving this publication, to an independent third party.

As always, I want to thank our team of Topic Editors, our loyal and accommodating Review Board Members, and *you*, our readers and contributors, who have helped launch these transactions and continue to keep it on a positive slope. With that, please continue on to read Volume 3, Issue 6 of our IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

Yours sincerely,

PETER H. SIEGEL, *Editor-in-Chief*

Peter H. Siegel (S'77–M'83–SM'98–F'01) received the B.A. degree from Colgate University, Hamilton, NY, in 1976, and the Ph.D. degree from Columbia University, New York, in 1983.

He holds appointments as Faculty Associate in Electrical Engineering and Senior Scientist in Biology at Caltech and Senior Research Scientist at the Jet Propulsion Laboratory (JPL) in Pasadena, CA. He has been working in the areas of millimeter and submillimeter-wave technology and applications for 38 years and has PI'd or co-I'd more than 75 R&D programs and been involved in four major space flight instruments. He has published more than 275 articles in the THz field and has given more than 150 invited talks in the US and abroad on this subject. At JPL, he founded, and led for more than 20 years, the JPL Submillimeter Wave Advanced Technology (SWAT) team, a group of 20+ research scientists and engineers developing THz technology for NASA's near and long term space missions as well as for several DoD applications. At Caltech, Dr. Siegel is involved in new biological and medical applications of THz. His current interests are split between traditional Earth, planetary and astrophysics applications and new THz applications in medicine and biology.

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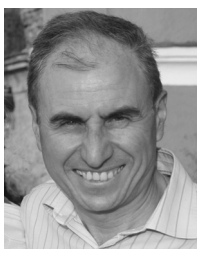

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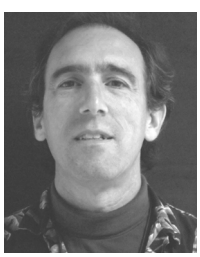

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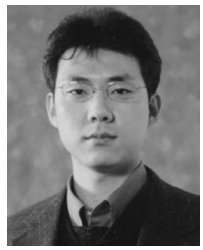

Haewook Han (M'12) received the B.S. and M.S. degrees in electrical engineering from Seoul National University, Seoul, Korea, in 1986 and 1988, respectively, and the Ph.D. degree in electrical engineering from the University of Illinois at Urbana-Champaign, Urbana, IL, USA, in 1995.

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Imran Mehdi (S'83–M'90–SM'09–F'10) received the B.S.E.E. degree in 1985, the M.S.E.E. degree in 1986, and the Ph.D. degree in 1990, all from the University of Michigan.

He is currently Principal Member of Engineering staff at the Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA, and Supervisor of the JPL Submillimeter-Wave advanced Technology (SWAT) team. His responsibilities include developing THz components and subsystems for current and future NASA missions. He joined JPL in 1990 where his first task included the design and fabrication of low-parasitic planar Schottky diodes for submillimeter-wave applications. These devices were implemented on the ozone monitoring Microwave Limb Sounder instrument launched in 2004, as well as the MIRO instrument which represents the first submillimeter-wave receiver that will rendezvous with a comet in 2014. From 1999, he led the effort of developing broadband solid-state sources from 200 to 2500 GHz for the Heterodyne Instrument for Far Infrared (HIFI) on the Herschel Space Observatory, a cornerstone European Space Agency mission currently in space. This effort led to realization of wide-band solid-state sources in the THz range enabling ground-breaking astrophysics observations in space as well as at many ground-based observatories. His current interests include both mm and sub-mm wave devices, semiconductor fabrication technology, high-frequency instrumentation, and heterodyne receivers for miniature systems.

Jan Stake (M'95) received the M.Sc. degree in electrical engineering and Ph.D. degree in microwave electronics from Chalmers University of Technology, Göteborg, Sweden, in 1994 and 1999, respectively.

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Christopher Walker has over 25 years experience designing, building, and using state-of-the-art receiver systems for THz astronomy. He is a Professor of Astronomy and an Associate Professor of Optical Sciences and Electrical Engineering at the University of Arizona (U of A). He has worked in industry (TRW Aerospace and JPL) as well as academia. As a Millikan Fellow in Physics at Caltech, he worked on the development of low-noise, SIS waveguide receivers above 400 GHz and explored techniques for etching waveguide out of silicon. On joining the U of A faculty in 1991 he began the Steward Observatory Radio Astronomy Lab (SORAL), which has become a world leader in developing THz receiver systems for astronomy and other remote sensing applications. These instruments are multi-institutional efforts, with key components coming from JPL, several universities, and a number of industrial partners. He manages and coordinates these efforts. Instruments developed by Prof. Walker's team have served as primary facility instruments at the Heinrich Hertz Telescope on Mt. Graham, AZ, USA, and the AST/RO telescope at the South Pole. He is leading the effort to design and build the world's largest (64 pixels) submillimeter-wave heterodyne array receiver (SuperCam). He is also PI of the NASA funded long duration balloon project "The Stratospheric THz Observatory (STO)". He has published numerous papers on star formation and protostellar evolution. He has served as dissertation director for nine Ph.D. students.

Editorial

JANUARY 2014 marks our first issue in Volume 4 of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY. I am exceedingly pleased to be celebrating this milestone, and I believe I speak for all of our Editorial Board (we have just completed our 40th board meeting!), when I say it has been a great satisfaction to see that our efforts have been accepted by the THz community, and that our paper queue continues to grow. This month we are adding two new globally distributed Topic Editors to our board: Professor Alexander Shkurinov, from Moscow State University, and Professor Vince Wallace, from University of Western Australia. At the same time we bid farewell to Stefano Alberti of Ecole Polytechnique Federale de Lausanne, who has been helping out since the founding of our editorial committee in September 2010. My sincerest thanks for all the time and enthusiasm that Stefano, and all of our editors have put into the journal over the past four years.

It has become a bit of a tradition each January to bring you feature length articles from the prior year's *International Symposium on Space Terahertz Technology (ISSTT),* which has now completed its 24th conference. However, we have had some delays in getting all the papers through our review cycle in time for this month's print release, so I have postponed this year's *ISSTT Mini-Special Issue* until March. I am hoping to include a *Pioneer* article on renowned THz astronomer, Thijs de Graauw, as a lead in to the March issue, that will fit well with the *ISSTT* papers and will also coincide with this year's symposium in Russia, in April.

Instead of the *ISSTT Mini-Special issue*, our print lead-in for 2014 contains regular contributions only. As promised however, we are starting the year off by including in each print issue our new *THz Letters* section, which will host short papers (typically of 2–4 pages in length) on any relevant topic that fits within the scope of our publication. Our first article in this class is an Editorial/informational piece contributed by Michael Marcus, Marcus Communications, Falls Church, MD, USA, on commercial use of the THz spectrum. As the new *THz Letters* section catches on, we hope to be able to bring you many more short features with both strong technical and/or time critical content.

I think you will find our regular paper contributions this month quite interesting. The special *THz Pioneer* article is on the 60-year long career of a rather heroic figure in China, *Professor Shenggang Liu*, who pioneered the field of microwave vacuum electronics, and then used it as a foundation to launch what would normally be considered a "post-retirement" career in THz science and applications. I am certain you will find his story both inspiring and fascinating.

Our two lead off papers this month, one on THz Dosimetry, by Germany's Thomas Kleine-Ostmann *et al.* and the other on a demonstration of their new broad band THz leaky wave antenna, by Technical University of Delft's, Andrea Neto *et al.* merit particular attention. JPL's Theodore Reck *et al.* piece on demonstrated THz micromachined waveguide components is also noteworthy. The difficulty of making accurate high frequency MVNA measurements is presented in an article from University of Virginia's Huilin Li *et al.*, and several interesting component papers follow on transitions, amplifiers and field concentrators (Meysam Moallem, Klas Eriksson, and our own Erich Grossman, are the corresponding authors for these manuscripts). Other papers cover topics in submillimeter-wave communications (Cheng Wang *et al.*), water vapor and cloud distribution in the atmosphere (Jonathan Suen *et al.*), plasmonic devices (Mohammad Khorrami *et al.*), spectroscopy (Takashi Notake *et al.*) and graphene-based beam-scanning antennas (Marc Esquius-Morote *et al.*).

As usual, I want to thank our dedicated team of worldwide Topic Editors, our loyal and responsive Review Board Members, and *you*, our readers and contributors, who have helped keep these transactions interesting and exciting as we enter our third full calendar year of bi-monthly publication. Please continue on to read Volume 4, Issue 1 of our IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

Yours always,

PETER H. SIEGEL, *Editor-in-Chief*

Peter H. Siegel (S'77–M'83–SM'98–F'01) received the B.A. degree from Colgate University, Hamilton, NY, in 1976, and the Ph.D. degree from Columbia University, New York, in 1983.

He holds appointments as Faculty Associate in Electrical Engineering and Senior Scientist in Biology at Caltech and Senior Research Scientist at the Jet Propulsion Laboratory (JPL) in Pasadena, CA. He has been working in the areas of millimeter and submillimeter-wave technology and applications for 38 years and has PI'd or co-I'd more than 75 R&D programs and been involved in four major space flight instruments. He has published more than 275 articles in the THz field and has given more than 150 invited talks in the US and abroad on this subject. At JPL, he founded, and led for more than 20 years, the JPL Submillimeter Wave Advanced Technology (SWAT) team, a group of 20+ research scientists and engineers developing THz technology for NASA's near and long term space missions as well as for several DoD applications. At Caltech, Dr. Siegel is involved in new biological and medical applications of THz. His current interests are split between traditional Earth, planetary and astrophysics applications and new THz applications in medicine and biology.

Among many other duties, Dr. Siegel co-chaired and chaired for six years, and is now General Secretary for the International Conference for Infrared, Millimeter and Terahertz Waves (IRMMW-THz), the oldest and largest venue devoted to the field of far IR techniques, science and applications, and he served as conference organizer and chair for IRMMW-THz 2008 in Pasadena. He also set up and administers the International Society of Infrared, Millimeter and Terahertz Waves in 2010, a non-profit organization that is responsible for overseeing the conference series. He has served as an IEEE Distinguished Microwave

Digital Object Identifier 10.1109/TTHZ.2013.2294747

Lecturer, co-chair and chair of MTT Committee 4-THz Technology, a TPC and Speaker's bureau member, and as organizer and chair of seven sequential special sessions at the IEEE International Microwave Symposia. He is extremely pleased, and very excited to be involved in the formation and launching of the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY. (His Web Pages: http://www.thz.caltech.edu; http://www.irmmw-thz.org; http://www.thz.ieee.org, e-mail: phs@caltech.edu).

ADMINISTRATIVE EDITOR

Sharri Shaw was born in Michigan, and currently resides in Boulder, CO. She received the B.A. degree in english and a minor in psychology, from Saginaw Valley State University, in 1994. She continued her studies in 2001 in the Master in Education with Initial Certification (M.Ed.) program at Aquinas College, where she received her Secondary Level Teacher Certification.

From 2002 to 2005, she was a teacher in Michigan. From 2006 to 2010, she was the Assistant Editor of the IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES. She currently holds the same position with *IEEE Microwave Magazine*, and also serves as the Publications Administrator for the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

TOPIC EDITORS

Stefano Alberti received the Ph.D. degree from the Swiss Federal Institute of Technology (EPFL), Lausanne, Switzerland, in 1991, with his research dedicated to the study of quasi-optical gyrotrons.

After a two-year post-doctorate at MIT, Cambridge, MA, USA, where he worked on CARMs and X-Band relativistic-TWT, he returned in 1993 to the Centre for Plasma Physics Research (CRPP), EPFL. Since then, within the European high-power gyrotron development program, he worked at CRPP developing and testing high-power high-frequency gyrotrons for a variety of EC-system installed on magnetically confined plasma experiments, such as TCV at CRPP, Tore-Supra, W7-X and presently ITER. In parallel to this activity, he contributed to the design, installation and testing of complete electron-cyclotron system from plug to plasma for these same experiments. On TCV he actively contributed on performing electron-cyclotron heating and current-drive experiments. Since 2008, he is responsible for the development of frequency-tunable gyrotrons for DNP-enhanced NMR-spectroscopy. He is currently Lecturer at EPFL, where he teaches an introductory course in plasma physics. He is the author or coauthor of over 60 refereed publications.

René Beigang received the Diploma and Ph.D. degrees from the University of Hannover, Hannover, Germany.

He spent 3 years as a post-doctorate and visiting scientist at the IBM T. J. Watson Research Center, Yorktown Heights, NY. He was Associate Professor at the Free University of Berlin and the University of Kaiserslautern. He is now a full professor at the Department of Physics of the University of Kaiserslautern. Since 2005, he is also Head of the Department on Terahertz Measurement and Systems of the Fraunhofer Institute for Physical Measurement Techniques. His current research interests include nonlinear optics, generation and application of THz radiation, THz spectroscopy, applications of THz radiation in science and technology, realization and investigation of THz meta materials. (His homepage: http://www.physik.uni-kl.de/beigang).

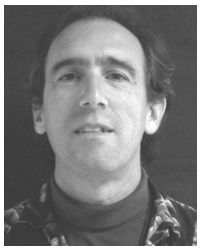
A. Giles Davies received the B.Sc. degree in chemical physics from the University of Bristol, Bristol, U.K., in 1987, and the Ph.D. degree in semiconductor physics from the University of Cambridge, Cambridge, U.K., in 1991.

He is currently Professor of Electronic and Photonic Engineering at the University of Leeds, Leeds, U.K. His research interests concentrate on the electrical and optical properties of low- dimensional and nanostructured electronic systems, and multilayered semiconductor devices, with particular recent focus on the development of terahertz frequency systems and the exploitation of biological processes for nanoscale assembly.

Gian Piero Gallerano received the Laurea Degree (Ph.D.) in physics from the University of Rome, Italy in 1980 with a thesis on the realization of a tunable color center laser in the near infrared.

In 1981, he was a Visiting Fellow at the Technical University Hannover, Germany. In 1983 he joined the High Power Laser Laboratory at ENEA Research Center, Frascati to work on the development of infrared free electron lasers (FEL). In 1991 he was a Visiting Scholar at the Ginzton Laboratory, EE Dept, Stanford University. His work on FELs lead to the realization of the ENEA Compact FEL (90–150 GHz) and of the Compact Advanced THz Source, FEL-CATS (0.4–0.7 THz). From 2001 to 2004 he has been the Coordinator of the European project THz-BRIDGE involving ten research institutes in the study the interaction of THz radiation with biological systems. From 2005 to 2007, he was in charge of the ENEA participation in the European project EUROFEL. He is currently the Head of the Radiation Sources Laboratory at ENEA Frascati. His areas of interest include generation of THz radiation and its application in the biological, biomedical, environmental and art conservation fields, THz imaging techniques, coherent emission from RF modulated electron beams, free electron lasers, optical design and diagnostics in the infrared.

Dr. Gallerano organized the "35th International Conference on Infrared, Millimeter and THz Waves" IRMMW-THz 2010 held in Rome, Italy, September 5–10, 2010., and currently chairs the International Society of Infrared, Millimeter and Terahertz Waves, the oldest and largest forum devoted to scientific and technological developments in the wide spectral range extending from the infrared to the millimeter wave region. He has been a member of the Italian Physical Society since 1981, and is a member of the Bioelectromagnetics Society.



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Alexander Shkurinov graduated in 1985 with honors from the Department of Physics of M.V. Lomonosov Moscow State University (MSU), and received the Ph.D. degree in physics from MSU in 1988.

In 1989, he became Research Scientist at the R.V.Khohlov Laboratory of Non-Linear Optics at MSU. His research interests are centered on the development and application of femtosecond laser techniques, time-resolved spectroscopy of molecules in the liquid phase, nonlinear optics and terahertz techniques and spectroscopy.

Dr. Shkurinov has participated in a wide range of scientific advisory boards and sat on the organizing and program committees of numerous international conferences. He was awarded the Rozhdestvensky Medal from the Russian Optical Society for his contribution into the development of optical science and technology in 2008.

Jan Stake (M'95) received the M.Sc. degree in electrical engineering and Ph.D. degree in microwave electronics from Chalmers University of Technology, Göteborg, Sweden, in 1994 and 1999, respectively.

In 1997, he was a Research Assistant at the University of Virginia, Charlottesville, VA, USA. From 1999 to 2001, he was a Research Fellow in the millimeter wave group at the Rutherford Appleton Laboratory, U.K. He then joined Saab Combitech Systems AB as a Senior RF/microwave Engineer until 2003. From 2000 to 2006, he held different academic positions at Chalmers and was also Head of the Nanofabrication Laboratory at MC2 between 2003 and 2006. During 2007, he was a Visiting Professor in the Submillimeter Wave Advanced Technology (SWAT) group at Caltech/JPL, exploring THz applications in biology and medicine. He is currently Professor and Head of the Terahertz and Millimetre Wave Laboratory, Chalmers, Switzerland. His research involves terahertz sources, detectors and mixers, high frequency semiconductor devices, graphene electronics, terahertz measurement techniques and applications.

Christopher Walker has over 25 years experience designing, building, and using state-of-the-art receiver systems for THz astronomy. He is a Professor of Astronomy and an Associate Professor of Optical Sciences and Electrical Engineering at the University of Arizona (U of A). He has worked in industry (TRW Aerospace and JPL) as well as academia. As a Millikan Fellow in Physics at Caltech, he worked on the development of low-noise, SIS waveguide receivers above 400 GHz and explored techniques for etching waveguide out of silicon. On joining the U of A faculty in 1991 he began the Steward Observatory Radio Astronomy Lab (SORAL), which has become a world leader in developing THz receiver systems for astronomy and other remote sensing applications. These instruments are multi-institutional efforts, with key components coming from JPL, several universities, and a number of industrial partners. He manages and coordinates these efforts. Instruments developed by Prof. Walker's team have served as primary facility instruments at the Heinrich Hertz Telescope on Mt. Graham, AZ, USA, and the AST/RO telescope at the South Pole. He is leading the effort to design and build the world's largest (64 pixels) submillimeter-wave heterodyne array receiver (SuperCam). He is also PI of the NASA funded long duration balloon project "The Stratospheric THz Observatory (STO)". He has published numerous papers on star formation and protostellar evolution. He has served as dissertation director for nine Ph.D. students.

Vincent Wallace received the Ph.D. degee in medical physics from the University of London, London, U.K., in 1997.

He has nearly 20 years of experience in Biophotonics. After four years as a post doctorate at the Beckman Laser Institute and Medical Clinic, University of California, Irvine, CA, USA he joined Toshiba Research in Cambridge, U.K., to look at potential applications of terahertz radiation. The terahertz group was spun-out of Toshiba Labs in April 2001 and became TeraView Ltd, also based in Cambridge. At TeraView, he led a group investigation the biomedical applications of terahertz technology. In 2007, he moved to the University of Western Australia to take up a full time academic role where he continues to apply terahertz and other optical techniques to biomedical and clinical problems and the understanding of the interaction of electromagnetic radiation with tissues.

Editorial

MARCH brings to the fore our *Special Mini-Issue on the 24th International Symposium on Space Terahertz Technology (ISSTT)* and also the announcement of our 2014 IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY Best Paper Award.

I am both pleased and honored to present the winning paper, **"Silicon Micromachined Lens Antenna for THz Integrated Heterodyne Arrays"** by Nuria Llombart, C. Lee, M. Alonso-del Pino, G. Chattopadhyay, C. Jung-Kubiak, L. Jofre, and I. Mehdi, which appeared in IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY, vol. 3, no. 5, pp. 515–523, September 2013. My heartfelt congratulations to all the authors for this nicely presented, innovative piece of research.

This year the award committee would also like to recognize a *Topic Editors' Special Mention* for **"Graphical Prediction of Trapped Mode Resonances in Sub-mm and THz Waveguide Networks"** by Matthew A. Morgan and Shing-Kuo Pan, appearing in IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY, vol. 3, no. 1, pp. 75–80, January 2013. This quite refreshing style, and the useful nature of the presented method will certainly find an appreciative audience in those who work in the more traditional RF guided wave field.

Both teams will be recognized at the *39th International Conference on Terahertz Science and Technology* in Tucson, AZ, this September 14–19, 2014 (www.irmmw-thz2014.org), as well as by the IEEE MTT Society. I would like to thank both groups of authors for their contributions, as well as our Topic Editors and our Awards Committee, for their efforts in choosing the prize winner.

This month we begin our print issue with a THz Pioneer article on astronomer Thijs de Graauw, long time director at SRON, the Netherlands Institute for Space Research; principal investigator on two major space flight instruments (ISO's SWS and Herschel Space Observatory's HIFI); and director of the Atacama Large Millimeter Array (ALMA) observatory. I am certain this article will impress anyone who is hoping to have a career doing "big" science.

Appropriately, we follow Thijs's piece with our special mini-issue containing expanded papers from the *24th International Symposium on Space Terahertz Technology (ISSTT),* which coincidentally took place last April at SRON, where Thijs de Graauw worked for 17 years. A special thanks to our Special Mini-Issue Editors, Imran Mehdi and Andrey Baryshev, who introduce the seven ISSTT special section papers after the THz Pioneer article.

Our regular submissions this month include an additional ten papers, led, appropriately, by an ALMA receiver article by Kerr *et al.* from National Radio Astronomy Observatory. This is followed by an innovative approach to thermal design from Zimmermann *et al.* at the University of Arizona; and a flexible substrate high frequency circuit structure from Inoue *et al.* at Japan's NITTO and Osaka University. Another interesting THz radar paper is contributed by Blazquez, Cooper, and Llombart (our 2013 THz Best paper prize winner), and after this, an imaging technique based on FDTD methods from Bardak *et al.* at Texas Tech. Thick mesh filters are the subject of the article from groups in the U.K. led by Yi Wang; and Billade *et al.* looks at using SIS junctions to realize frequency multipliers. Our last three regular issue papers cover photomixing (Rolland *et al.* from France); thermal studies of Schottky diodes from Finland and Sweden (Khanal *et al.*); and models of these same solid-state devices from Pardo *et al.* in Spain. I hope you will enjoy the variety of topics in this month's issue.

On a more general theme, I am trying something a little new on the inside rear cover. We will now print only the names of *Review Board* members who have contributed one or more paper reviews within the listed period. As we continue to grow, we have simply run out of space for acknowledging everyone who has contributed over the years. I will try to keep the list up to date, but please let me know if your name is listed incorrectly, or you have been inadvertently left out.

For those who managed to stop by our display booth—at the *Photonics West Exhibition* between February 4–6, 2014, in San Francisco, CA—a special thanks. It was fun chatting and we gave out a large number of the Transactions samples to interested photonics researchers.

Please remember to start sending in short papers for our new *THz Letters* section, these should start appearing more regularly later this summer.

Finally, I want to again thank our team of Topic Editors, our loyal and responsive Review Board Members, and *you*, our readers and contributors, who have helped keep these transactions interesting and exciting as we continue to try and serve the widest possible THz community. Please turn the page to begin reading Volume 4, Issue 2 of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

Yours always,

PETER H. SIEGEL, *Editor-in-Chief*

Peter H. Siegel (S'77–M'83–SM'98–F'01) received the B.A. degree from Colgate University, Hamilton, NY, in 1976, and the Ph.D. degree from Columbia University, New York, in 1983.

He holds appointments as Faculty Associate in Electrical Engineering and Senior Scientist in Biology at Caltech and Senior Research Scientist at the Jet Propulsion Laboratory (JPL) in Pasadena, CA. He has been working in the areas of millimeter and submillimeter-wave technology and applications for 38 years and has PI'd or co-I'd more than 75 R&D programs and been involved in four major space flight instruments. He has published more than 275 articles in the THz field and has given more than 150 invited talks in the US and abroad on this subject. At JPL, he founded, and led for more than 20 years, the JPL Submillimeter Wave Advanced Technology (SWAT) team, a group of 20+ research scientists and engineers developing THz

Digital Object Identifier 10.1109/TTHZ.2014.2305164

technology for NASA's near and long term space missions as well as for several DoD applications. At Caltech, Dr. Siegel is involved in new biological and medical applications of THz. His current interests are split between traditional Earth, planetary and astrophysics applications and new THz applications in medicine and biology.

Among many other duties, Dr. Siegel co-chaired and chaired for six years, and is now General Secretary for the International Conference for Infrared, Millimeter and Terahertz Waves (IRMMW-THz), the oldest and largest venue devoted to the field of far IR techniques, science and applications, and he served as conference organizer and chair for IRMMW-THz 2008 in Pasadena. He also set up and administers the International Society of Infrared, Millimeter and Terahertz Waves in 2010, a non-profit organization that is responsible for overseeing the conference series. He has served as an IEEE Distinguished Microwave Lecturer, co-chair and chair of MTT Committee 4-THz Technology, a TPC and Speaker's bureau member, and as organizer and chair of seven sequential special sessions at the IEEE International Microwave Symposia. He is extremely pleased, and very excited to be involved in the formation and launching of the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY. (His Web Pages: http://www.thz.caltech.edu; http://www.irmmw-thz.org; http://www.thz.ieee.org, e-mail: phs@caltech.edu).

ADMINISTRATIVE EDITOR

Sharri Shaw was born in Michigan, and currently resides in Boulder, CO. She received the B.A. degree in english and a minor in psychology, from Saginaw Valley State University, in 1994. She continued her studies in 2001 in the Master in Education with Initial Certification (M.Ed.) program at Aquinas College, where she received her Secondary Level Teacher Certification.

From 2002 to 2005, she was a teacher in Michigan. From 2006 to 2010, she was the Assistant Editor of the IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES. She currently holds the same position with *IEEE Microwave Magazine*, and also serves as the Publications Administrator for the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

TOPIC EDITORS

René Beigang received the Diploma and Ph.D. degrees from the University of Hannover, Hannover, Germany.

He spent 3 years as a post-doctorate and visiting scientist at the IBM T. J. Watson Research Center, Yorktown Heights, NY. He was Associate Professor at the Free University of Berlin and the University of Kaiserslautern. He is now a full professor at the Department of Physics of the University of Kaiserslautern. Since 2005, he is also Head of the Department on Terahertz Measurement and Systems of the Fraunhofer Institute for Physical Measurement Techniques. His current research interests include nonlinear optics, generation and application of THz radiation, THz spectroscopy, applications of THz radiation in science and technology, realization and investigation of THz meta materials. (His homepage: http://www.physik.uni-kl.de/beigang).

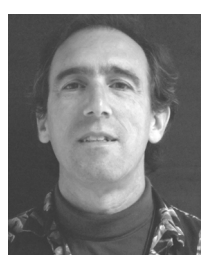
A. Giles Davies received the B.Sc. degree in chemical physics from the University of Bristol, Bristol, U.K., in 1987, and the Ph.D. degree in semiconductor physics from the University of Cambridge, Cambridge, U.K., in 1991.

He is currently Professor of Electronic and Photonic Engineering at the University of Leeds, Leeds, U.K. His research interests concentrate on the electrical and optical properties of low-dimensional and nanostructured electronic systems, and multilayered semiconductor devices, with particular recent focus on the development of terahertz frequency systems and the exploitation of biological processes for nanoscale assembly.

Gian Piero Gallerano received the Laurea Degree (Ph.D.) in physics from the University of Rome, Italy, in 1980 with a thesis on the realization of a tunable color center laser in the near infrared.

In 1981, he was a Visiting Fellow at the Technical University Hannover, Germany. In 1983 he joined the High Power Laser Laboratory at ENEA Research Center, Frascati to work on the development of infrared free electron lasers (FEL). In 1991, he was a Visiting Scholar at the Ginzton Laboratory, EE Department, Stanford University. His work on FELs lead to the realization of the ENEA Compact FEL (90–150 GHz) and of the Compact Advanced THz Source, FEL-CATS (0.4–0.7 THz). From 2001 to 2004, he has been the Coordinator of the European project THz-BRIDGE involving ten research institutes in the study the interaction of THz radiation with biological systems. From 2005 to 2007, he was in charge of the ENEA participation in the European project EUROFEL. He is currently the Head of the Radiation Sources Laboratory at ENEA Frascati. His areas of interest include generation of THz radiation and its application in the biological, biomedical, environmental and art conservation fields, THz imaging techniques, coherent emission from RF modulated electron beams, free electron lasers, optical design and diagnostics in the infrared.

Dr. Gallerano organized the "35th International Conference on Infrared, Millimeter and THz Waves" IRMMW-THz 2010 held in Rome, Italy, September 5–10, 2010., and currently chairs the International Society of Infrared, Millimeter and Terahertz Waves, the oldest and largest forum devoted to scientific and technological developments in the wide spectral range extending from the infrared to the millimeter wave region. He has been a member of the Italian Physical Society since 1981, and is a member of the Bioelectromagnetics Society.



Erich N. Grossman received the A.B. degree in physics from Harvard College, Cambridge, MA, in 1980, and a Ph.D. degree, also in physics, from the California Institute of Technology, Pasadena, in 1987. His thesis work involved development of an ultra-low noise, heterodyne receiver for 2 THz astronomy.

From 1988 to 1989, he was a post-doctoral fellow at the University of Texas at Austin, TX, USA, and in 1989, he joined the National Institute of Standards and Technology, Boulder, CO, USA, where he is now a physicist in the Optoelectronics Division. His work at NIST focuses on infrared and submillimeter system development.

Dr. Grossman's notable accomplishments include the development and demonstration of the world's highest frequency, high efficiency lithographic antennas, the world's highest frequency Josephson junctions, (awarded a Department of Commerce Gold Medal in 1993), and early conception and development of the SQUID multiplexer, first enabling large monolithic arrays of superconducting detectors. More recently, he has developed several 0.1–1 THz cameras for security applications. He is also chair of the Metrology Working Group for the DARPA Terahertz Electronics program.

Haewook Han (M'12) received the B.S. and M.S. degrees in electrical engineering from Seoul National University, Seoul, Korea, in 1986 and 1988, respectively, and the Ph.D. degree in electrical engineering from the University of Illinois at Urbana-Champaign, Urbana, IL, USA, in 1995.

He studied low-threshold strained quantum-well heterostructure lasers and two-dimensional photonic crystal semiconductor lasers. At Bell Laboratories, Murray Hill, NJ, USA, from 1995 to 1997, he contributed to the development of 980-nm high-power semiconductor lasers. He is currently Associate Professor of the Department of Electrical and Computer Engineering at the Pohang University of Science and Technology (POSTECH). He co-founded the Korea THz Forum, and served as the Director of the Center for THz Photonics (1998–2000) and the National Laboratory for Nano-THz Photonics (2005–2009). He invented THz plastic photonic crystal fibers for single-mode THz pulse transmission in 2001. His current research interests include THz hydration dynamics of biomolecules, THz quantum interactions, and THz near-field microscopy and spectroscopy.

Peter Uhd Jepsen (M'10) received the M.Sc. degree in physics and chemistry from Odense University, Denmark, in 1994, and the Ph.D. degree in natural sciences from Århus University, Denmark in 1996.

He was at the University of Freiburg, Germany from 1996 to 2004, working with terahertz time-domain spectroscopy. From 2005, he was Associate Professor at the Technical University of Denmark (DTU), and since 2008, Professor and Head of the Terahertz Technologies and Biophotonics group at DTU. In 2008/2009, he was Visiting Professor at Osaka University. His research areas include photonics-based THz technology, broadband THz spectroscopy for chemical sensing, imaging, chemistry, and water dynamics in the THz range, and time-resolved THz spectroscopy of ultrafast phenomena in the THz range.

Kodo Kawase received the B.S. degree in electronic engineering from Kyoto University in 1989, Japan, and the Ph.D. degree in electronic engineering from Tohoku University, Japan, in 1996.

He became an Initiative Researcher at RIKEN in 2001 and a Professor in the Graduate School of Engineering, Nagoya University, Japan, in 2005. He has been conducting research activities in several directions within the THz field. Professor Kawase developed several types of widely tunable THz sources using nonlinear optical effects, and implemented them for a wide range of real-life applications. He has published more than 130 articles in the THz field and has given more than 160 invited talks on this subject.

Dr. Kawase received the 1997 Young Scientist Award from the JSAP, the 1998 Excellent Presentation Award, the 2000 and 2006 Prize of Laser Engineering from the Laser Society of Japan, the 2002 Marubun research and encouragement award and the 2006 Marubun Special Research Award from the Marubun Research Promotion Foundation (MRPF), and the 2005 Young Scientists' Prize by the Commendation for Science and Technology of the Minister of Education, Culture, Science and Technology (MEXT).

Nuria Llombart received the Electrical Engineering degree and Ph.D. degree from the Polytechnic University of Valencia, Spain, in 2002 and 2006, respectively.

During her Masters' degree studies she spent one year at the Friedrich-Alexander University of Erlangen-Nuremberg, Germany, and worked at the Fraunhofer Institute for Integrated Circuits, Erlangen, Germany. From 2002 until 2007, she was with the Antenna Group at the TNO Defence, Security and Safety Institute, The Hague, The Netherlands, working as Ph.D. student and afterwards as a researcher. From 2007 until 2010, she was a Post-Doctoral Fellow at the California Institute of Technology, working for the Sub millimeter Wave Advance Technology group of the Jet Propulsion Laboratory (JPL), Pasadena, CA, USA. From 2010 to 2012, she held a "Ramón y Cajal" fellowship at the Optics Department of the Complutense University of Madrid, Spain. She recently relocated to Technical University of Delft, Netherlands, where she is a professor in the Electrical Engineering department, and she continues to be an affiliate at JPL, Pasadena. Her research interests include the analysis and design of planar antennas, periodic structures, reflector antennas, lens antennas, waveguide structures, with emphasis in the THz range.

Dr. Llombart was co-recipient of the H. A. Wheeler Award for the Best Applications Paper of 2008 in the IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION. She was also a co-recipient of an Honorable Mention at the 2010 European Conference of Antennas.

Victor M. Lubecke received the B.S.E.E. degree from the California State Polytechnic Institute, Pomona, CA, USA, in 1986, and the M.S. and Ph.D. degrees in electrical engineering from the California Institute of Technology, Pasadena, CA, USA, in 1990 and 1995, respectively.

He is currently a professor of Electrical Engineering at the University of Hawaii, Manoa, HI, USA. From 1998 to 2003, Dr. Lubecke was with Bell Laboratories, Lucent Technologies, where his research focused on remote sensing technologies for biomedical and industrial applications, and on microelectromechanical systems (MEMS) and 3-D wafer-scale integration technologies for wireless and optical communications. From 1987 through 1996, he was with the NASA Jet Propulsion Laboratory (JPL), and from 1996 to 1998, he was with the Institute for Physical and Chemical Research (RIKEN), Sendai, Japan, where his research involved terahertz and MEMS technologies for space remote sensing and communications applications. He holds 6 U.S. patents with several pending, and has published over 150 peer-reviewed research articles.

Prof. Lubecke is an emeritus Distinguished Microwave Lecturer (2006–2008) of the IEEE Microwave Theory and Techniques Society, and was co-recipient of the Emerging Technology Award at TechConnect 2007. He co-founded and served as CTO for a start-up company that is now Kai Medical, Honolulu, HI. His current research interests include remote sensing technologies, biomedical sensors, MEMS, heterogeneous integration, and microwave/terahertz radio.

Imran Mehdi (S'83–M'90–SM'09–F'10) received the B.S.E.E. degree in 1985, the M.S.E.E. degree in 1986, and the Ph.D. degree in 1990, all from the University of Michigan.

He is currently Principal Member of Engineering staff at the Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA, and Supervisor of the JPL Submillimeter-Wave advanced Technology (SWAT) team. His responsibilities include developing THz components and subsystems for current and future NASA missions. He joined JPL in 1990 where his first task included the design and fabrication of low-parasitic planar Schottky diodes for submillimeter-wave applications. These devices were implemented on the ozone monitoring Microwave Limb Sounder instrument launched in 2004, as well as the MIRO instrument which represents the first submillimeter-wave receiver that will rendezvous with a comet in 2014. From 1999, he led the effort of developing broadband solid-state sources from 200 to 2500 GHz for the Heterodyne Instrument for Far Infrared (HIFI) on the Herschel Space Observatory, a cornerstone European Space Agency mission currently in space. This effort led to realization of wide-band solid-state sources in the THz range enabling ground-breaking astrophysics observations in space as well as at many ground-based observatories. His current interests include both mm and sub-mm wave devices, semiconductor fabrication technology, high-frequency instrumentation, and heterodyne receivers for miniature systems.

Alexander Shkurinov graduated in 1985 with honors from the Department of Physics of M.V. Lomonosov Moscow State University (MSU), and received the Ph.D. degree in physics from MSU in 1988.

In 1989, he became Research Scientist at the R.V. Khohlov Laboratory of Non-Linear Optics at MSU. His research interests are centered on the development and application of femtosecond laser techniques, time-resolved spectroscopy of molecules in the liquid phase, nonlinear optics and terahertz techniques and spectroscopy.

Dr. Shkurinov has participated in a wide range of scientific advisory boards and sat on the organizing and program committees of numerous international conferences. He was awarded the Rozhdestvensky Medal from the Russian Optical Society for his contribution into the development of optical science and technology in 2008.

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Editorial

MAY marks our 17th print issue release of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY. Having recently caught up with all the correspondence from the "Comments to the Editor" box that appears when you upload your final manuscript files, I am both pleased and overwhelmed with the very positive response the journal is having within the Terahertz community. Before we close out the summer, we should have an initial *Impact Factor* from Reuters and, with the addition of the new *THz Letters* section, I hope we will finally be set to take up a permanent place in the science journal marketplace.

This month we bring you regular issue papers only. Our *THz Pioneer* subject for May, Professor Tatsuo Itoh of UCLA, is an individual that needs no introductions within the microwave community, but may not be as well recognized within the THz world. I hope you will find his story inspiring.

Our submitted papers for May span a range of topics from submillimeter-wave radar systems (*S. Liao, N. Gopalsami, S. Bakhtiari, T. W. Elmer, II, E. R. Koehl, and A. C. Raptis*) to superconducting bolometers with kinetic inductance detector filters (*L. S. Kuzmin*), to reconfiguarable arrays (*A. Kannegulla, Z. Jiang, S. M. Rahman, M. I. B. Shams, P. Fay, H. G. Xing, L.-J. Cheng, and L. Liu*). We also present an article on a 400 GHz wireless link (*G. Ducournau, P. Szriftgiser, A. Beck, D. Bacquet, F. Pavanello, E. Peytavit, M. Zaknoune, T. Akalin, and J.-F. Lampin*), two papers on measurement techniques (*M. Moallem and K. Sarabandi*) and (*A. Svetlitza, M. Slavenko, T. Blank, I. Brouk, S. Stolyarova, and Y. Nemirovsky*), and a paper on electric field enhancement in a 3-D tapered helix antenna (*V. Varlamava, F. Palma, P. Nenzi, and M. Balucani*).

These are followed by a paper on surface roughness effects on conductivity (*B. B. Yang, M.P. Kirley, and J. H. Booske*), and two papers on passive THz components: wire grid polarizers (*J. R. Middendorf, J. S. Cetnar, J. Owsley, and E. R. Brown*), and square hole electrodes (*G. K. Shirmanesh, E. Yarmoghaddam, A. Khavasi, and K. Mehrany*). Our last paper is on a high frequency CMOS amplifier, a rather popular topic these days (*K.-L. Wu, K.-T. Lai, R. Hu, C. F. Jou, D.-C. Niu, and Y.-S. Shiao*).

Our next scheduled Special Issue was announced in the March issue and is titled: **Terahertz Nanomaterials and Applications**. Guest Editors include Dr. Goutam Chattopadhyay, JPL, Pasadena, CA, USA (goutam.chattopadhyay@jpl.nasa.gov), Dr. Luca Pierantoni, Unversita Politechnica delle Marche, Ancona, Italy (l.pierantoni@univpm.it), Dr. Thomas Mitchell Wallis, NIST, Boulder, CO, USA (thomas.wallis@nist.gov), and Dr. Fabio Coccetti, CNRS-LAAS, (coccetti@laas.fr). If you have papers you think would be appropriate for this special issue, please feel free to contact any of the Guest Editors with a cc to phs@caltech.edu, well before the manuscript deadline of October 31, 2014.

Please remember to start sending in shorter papers to our new *THz Letters* section, so we can start having these appear each issue.

As I try to do as often as possible, I want to again acknowledge the continuing efforts of our team of Topic Editors, our loyal, growing, and responsive Review Board Members, and *you*, our readers and contributors, who are helping to keep our fledgling journal relevant and exciting. Most of all, I am hoping this year to greatly expand our scope and our outreach so we can best serve the entire THz community. Please turn the page to begin Volume 4, Issue 3, of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

Yours truly,

PETER H. SIEGEL, *Editor-in-Chief*

Peter H. Siegel (S'77–M'83–SM'98–F'01) received the B.A. degree from Colgate University, Hamilton, NY, in 1976, and the Ph.D. degree from Columbia University, New York, in 1983.

He holds appointments as Faculty Associate in Electrical Engineering and Senior Scientist in Biology at Caltech and Senior Research Scientist at the Jet Propulsion Laboratory (JPL) in Pasadena, CA. He has been working in the areas of millimeter and submillimeter-wave technology and applications for 38 years and has PI'd or co-I'd more than 75 R&D programs and been involved in four major space flight instruments. He has published more than 275 articles in the THz field and has given more than 150 invited talks in the US and abroad on this subject. At JPL, he founded, and led for more than 20 years, the JPL Submillimeter Wave Advanced Technology (SWAT) team, a group of 20+ research scientists and engineers developing THz technology for NASA's near and long term space missions as well as for several DoD applications. At Caltech, Dr. Siegel is involved in new biological and medical applications of THz. His current interests are split between traditional Earth, planetary and astrophysics applications and new THz applications in medicine and biology.

Among many other duties, Dr. Siegel co-chaired and chaired for six years, and is now General Secretary for the International Conference for Infrared, Millimeter and Terahertz Waves (IRMMW-THz), the oldest and largest venue devoted to the field of far IR techniques, science and applications, and he served as conference organizer and chair for IRMMW-THz 2008 in Pasadena. He also set up and administers the International Society of Infrared, Millimeter and Terahertz Waves in 2010, a non-profit organization that is responsible for overseeing the conference series. He has served as an IEEE Distinguished Microwave Lecturer, co-chair and chair of MTT Committee 4-THz Technology, a TPC and Speaker's bureau member, and as organizer and chair of seven sequential special sessions at the IEEE International Microwave Symposia. He is extremely pleased, and very excited to be involved in the formation and launching of the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY. (His Web Pages: http://www.thz.caltech.edu; http://www.irmmw-thz.org; http://www.thz.ieee.org, e-mail: phs@caltech.edu).

Digital Object Identifier 10.1109/TTHZ.2014.2315757

ADMINISTRATIVE EDITOR

Sharri Shaw was born in Michigan, and currently resides in Boulder, CO. She received the B.A. degree in english and a minor in psychology, from Saginaw Valley State University, in 1994. She continued her studies in 2001 in the Master in Education with Initial Certification (M.Ed.) program at Aquinas College, where she received her Secondary Level Teacher Certification.

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TOPIC EDITORS

René Beigang received the Diploma and Ph.D. degrees from the University of Hannover, Hannover, Germany.

He spent 3 years as a post-doctorate and visiting scientist at the IBM T. J. Watson Research Center, Yorktown Heights, NY. He was Associate Professor at the Free University of Berlin and the University of Kaiserslautern. He is now a full professor at the Department of Physics of the University of Kaiserslautern. Since 2005, he is also Head of the Department on Terahertz Measurement and Systems of the Fraunhofer Institute for Physical Measurement Techniques. His current research interests include nonlinear optics, generation and application of THz radiation, THz spectroscopy, applications of THz radiation in science and technology, realization and investigation of THz meta materials. (His homepage: http://www.physik.uni-kl.de/beigang).

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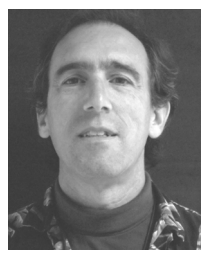

Erich N. Grossman received the A.B. degree in physics from Harvard College, Cambridge, MA, in 1980, and a Ph.D. degree, also in physics, from the California Institute of Technology, Pasadena, in 1987. His thesis work involved development of an ultra-low noise, heterodyne receiver for 2 THz astronomy.

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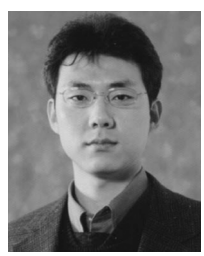

Haewook Han (M'12) received the B.S. and M.S. degrees in electrical engineering from Seoul National University, Seoul, Korea, in 1986 and 1988, respectively, and the Ph.D. degree in electrical engineering from the University of Illinois at Urbana-Champaign, Urbana, IL, USA, in 1995.

He studied low-threshold strained quantum-well heterostructure lasers and two-dimensional photonic crystal semiconductor lasers. At Bell Laboratories, Murray Hill, NJ, USA, from 1995 to 1997, he contributed to the development of 980-nm high-power semiconductor lasers. He is currently Associate Professor of the Department of Electrical and Computer Engineering at the Pohang University of Science and Technology (POSTECH). He co-founded the Korea THz Forum, and served as the Director of the Center for THz Photonics (1998–2000) and the National Laboratory for Nano-THz Photonics (2005–2009). He invented THz plastic photonic crystal fibers for single-mode THz pulse transmission in 2001. His current research interests include THz hydration dynamics of biomolecules, THz quantum interactions, and THz near-field microscopy and spectroscopy.

Peter Uhd Jepsen (M'10) received the M.Sc. degree in physics and chemistry from Odense University, Denmark, in 1994, and the Ph.D. degree in natural sciences from Århus University, Denmark in 1996.

He was at the University of Freiburg, Germany from 1996 to 2004, working with terahertz time-domain spectroscopy. From 2005, he was Associate Professor at the Technical University of Denmark (DTU), and since 2008, Professor and Head of the Terahertz Technologies and Biophotonics group at DTU. In 2008/2009, he was Visiting Professor at Osaka University. His research areas include photonics-based THz technology, broadband THz spectroscopy for chemical sensing, imaging, chemistry, and water dynamics in the THz range, and time-resolved THz spectroscopy of ultrafast phenomena in the THz range.

Kodo Kawase received the B.S. degree in electronic engineering from Kyoto University in 1989, Japan, and the Ph.D. degree in electronic engineering from Tohoku University, Japan, in 1996.

He became an Initiative Researcher at RIKEN in 2001 and a Professor in the Graduate School of Engineering, Nagoya University, Japan, in 2005. He has been conducting research activities in several directions within the THz field. Professor Kawase developed several types of widely tunable THz sources using nonlinear optical effects, and implemented them for a wide range of real-life applications. He has published more than 130 articles in the THz field and has given more than 160 invited talks on this subject.

Dr. Kawase received the 1997 Young Scientist Award from the JSAP, the 1998 Excellent Presentation Award, the 2000 and 2006 Prize of Laser Engineering from the Laser Society of Japan, the 2002 Marubun research and encouragement award and the 2006 Marubun Special Research Award from the Marubun Research Promotion Foundation (MRPF), and the 2005 Young Scientists' Prize by the Commendation for Science and Technology of the Minister of Education, Culture, Science and Technology (MEXT).

Nuria Llombart received the Electrical Engineering degree and Ph.D. degree from the Polytechnic University of Valencia, Spain, in 2002 and 2006, respectively.

During her Masters' degree studies she spent one year at the Friedrich-Alexander University of Erlangen-Nuremberg, Germany, and worked at the Fraunhofer Institute for Integrated Circuits, Erlangen, Germany. From 2002 until 2007, she was with the Antenna Group at the TNO Defence, Security and Safety Institute, The Hague, The Netherlands, working as Ph.D. student and afterwards as a researcher. From 2007 until 2010, she was a Post-Doctoral Fellow at the California Institute of Technology, working for the Sub millimeter Wave Advance Technology group of the Jet Propulsion Laboratory (JPL), Pasadena, CA, USA. From 2010 to 2012, she held a "Ramón y Cajal" fellowship at the Optics Department of the Complutense University of Madrid, Spain. She recently relocated to Technical University of Delft, Netherlands, where she is a professor in the Electrical Engineering department, and she continues to be an affiliate at JPL, Pasadena. Her research interests include the analysis and design of planar antennas, periodic structures, reflector antennas, lens antennas, waveguide structures, with emphasis in the THz range.

Dr. Llombart was co-recipient of the H. A. Wheeler Award for the Best Applications Paper of 2008 in the IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION. She was also a co-recipient of an Honorable Mention at the 2010 European Conference of Antennas.

Victor M. Lubecke received the B.S.E.E. degree from the California State Polytechnic Institute, Pomona, CA, USA, in 1986, and the M.S. and Ph.D. degrees in electrical engineering from the California Institute of Technology, Pasadena, CA, USA, in 1990 and 1995, respectively.

He is currently a professor of Electrical Engineering at the University of Hawaii, Manoa, HI, USA. From 1998 to 2003, Dr. Lubecke was with Bell Laboratories, Lucent Technologies, where his research focused on remote sensing technologies for biomedical and industrial applications, and on microelectromechanical systems (MEMS) and 3-D wafer-scale integration technologies for wireless and optical communications. From 1987 through 1996, he was with the NASA Jet Propulsion Laboratory (JPL), and from 1996 to 1998, he was with the Institute for Physical and Chemical Research (RIKEN), Sendai, Japan, where his research involved terahertz and MEMS technologies for space remote sensing and communications applications. He holds 6 U.S. patents with several pending, and has published over 150 peer-reviewed research articles.

Prof. Lubecke is an emeritus Distinguished Microwave Lecturer (2006–2008) of the IEEE Microwave Theory and Techniques Society, and was co-recipient of the Emerging Technology Award at TechConnect 2007. He co-founded and served as CTO for a start-up company that is now Kai Medical, Honolulu, HI. His current research interests include remote sensing technologies, biomedical sensors, MEMS, heterogeneous integration, and microwave/terahertz radio.

Imran Mehdi (S'83–M'90–SM'09–F'10) received the B.S.E.E. degree in 1985, the M.S.E.E. degree in 1986, and the Ph.D. degree in 1990, all from the University of Michigan.

He is currently Principal Member of Engineering staff at the Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA, and Supervisor of the JPL Submillimeter-Wave advanced Technology (SWAT) team. His responsibilities include developing THz components and subsystems for current and future NASA missions. He joined JPL in 1990 where his first task included the design and fabrication of low-parasitic planar Schottky diodes for submillimeter-wave applications. These devices were implemented on the ozone monitoring Microwave Limb Sounder instrument launched in 2004, as well as the MIRO instrument which represents the first submillimeter-wave receiver that will rendezvous with a comet in 2014. From 1999, he led the effort of developing broadband solid-state sources from 200 to 2500 GHz for the Heterodyne Instrument for Far Infrared (HIFI) on the Herschel Space Observatory, a cornerstone European Space Agency mission currently in space. This effort led to realization of wide-band solid-state sources in the THz range enabling ground-breaking astrophysics observations in space as well as at many ground-based observatories. His current interests include both mm and sub-mm wave devices, semiconductor fabrication technology, high-frequency instrumentation, and heterodyne receivers for miniature systems.

Alexander Shkurinov graduated in 1985 with honors from the Department of Physics of M.V. Lomonosov Moscow State University (MSU), and received the Ph.D. degree in physics from MSU in 1988.

In 1989, he became Research Scientist at the R.V. Khohlov Laboratory of Non-Linear Optics at MSU. His research interests are centered on the development and application of femtosecond laser techniques, time-resolved spectroscopy of molecules in the liquid phase, nonlinear optics and terahertz techniques and spectroscopy.

Dr. Shkurinov has participated in a wide range of scientific advisory boards and sat on the organizing and program committees of numerous international conferences. He was awarded the Rozhdestvensky Medal from the Russian Optical Society for his contribution into the development of optical science and technology in 2008.

Jan Stake (M'95) received the M.Sc. degree in electrical engineering and Ph.D. degree in microwave electronics from Chalmers University of Technology, Göteborg, Sweden, in 1994 and 1999, respectively.

In 1997, he was a Research Assistant at the University of Virginia, Charlottesville, VA, USA. From 1999 to 2001, he was a Research Fellow in the millimeter wave group at the Rutherford Appleton Laboratory, U.K. He then joined Saab Combitech Systems AB as a Senior RF/microwave Engineer until 2003. From 2000 to 2006, he held different academic positions at Chalmers and was also Head of the Nanofabrication Laboratory at MC2 between 2003 and 2006. During 2007, he was a Visiting Professor in the Submillimeter Wave Advanced Technology (SWAT) group at Caltech/JPL, exploring THz applications in biology and medicine. He is currently Professor and Head of the Terahertz and Millimetre Wave Laboratory, Chalmers, Sweden. His research involves terahertz sources, detectors and mixers, high frequency semiconductor devices, graphene electronics, terahertz measurement techniques and applications.

Christopher Walker has over 25 years experience designing, building, and using state-of-the-art receiver systems for THz astronomy. He is a Professor of Astronomy and an Associate Professor of Optical Sciences and Electrical Engineering at the University of Arizona (U of A). He has worked in industry (TRW Aerospace and JPL) as well as academia. As a Millikan Fellow in Physics at Caltech, he worked on the development of low-noise, SIS waveguide receivers above 400 GHz and explored techniques for etching waveguide out of silicon. On joining the U of A faculty in 1991 he began the Steward Observatory Radio Astronomy Lab (SORAL), which has become a world leader in developing THz receiver systems for astronomy and other remote sensing applications. These instruments are multi-institutional efforts, with key components coming from JPL, several universities, and a number of industrial partners. He manages and coordinates these efforts. Instruments developed by Prof. Walker's team have served as primary facility instruments at the Heinrich Hertz Telescope on Mt. Graham, AZ, USA, and the AST/RO telescope at the South Pole. He is leading the effort to design and build the world's largest (64 pixels) submillimeter-wave heterodyne array receiver (SuperCam). He is also PI of the NASA funded long duration balloon project "The Stratospheric THz Observatory (STO)". He has published numerous papers on star formation and protostellar evolution. He has served as dissertation director for nine Ph.D. students.

Vincent Wallace received the Ph.D. degree in medical physics from the University of London, London, U.K., in 1997.

He has nearly 20 years of experience in Biophotonics. After four years as a post doctorate at the Beckman Laser Institute and Medical Clinic, University of California, Irvine, CA, USA he joined Toshiba Research in Cambridge, U.K., to look at potential applications of terahertz radiation. The terahertz group was spun-out of Toshiba Labs in April 2001 and became TeraView Ltd, also based in Cambridge. At TeraView, he led a group investigation the biomedical applications of terahertz technology. In 2007, he moved to the University of Western Australia to take up a full time academic role where he continues to apply terahertz and other optical techniques to biomedical and clinical problems and the understanding of the interaction of electromagnetic radiation with tissues.

Editorial

WE BEGIN the second half of our Volume 4 season with another "regular submissions only" issue. I was a bit concerned, when with only three weeks to go before our final submission deadline for July, we had only one paper completely though the proofing stage! However, after some very efficient work on the part of our Administrative Editor, Sharri Shaw, and a series of lightening speed responses on the part of both reviewers and submitting authors, we managed to pull out a very complete set of quality papers. For future planning purposes, it is helpful to note that our print issue final paper deadline typically falls 30 days before the start of the formal issue month, July 31st for our September issue, September 30th for our November issue, etc. Due to scheduling pileups at our printing office, a slip of even one or two days, can result in a delayed issue release of two or more weeks. We, therefore, must be extremely rigid about these deadlines. Note that the print issue release date does not impact the posting of Early Access manuscripts on IEEE Xplore.

We have several other important dates coming up for future issues. The deadline for submitting papers to our **Terahertz Nanomaterials and Applications** issue is October 31st. If you are interested in discussing a possible contribution, please contact our Special Issue Guest Editor-in-Chief, Goutam Chattopadhyay at: goutam.chattopadhyay@jpl.nasa.gov. Expanded papers from this April's **International Symposium on Space Terahertz Technology (ISSTT)** conference are being collected by mini-issue Guest Editor Gregory Goltsman (goltsman@mspu-phys.ru) and Topic Editor Imran Mehdi (imran.mehdi@jpl.nasa.gov). These papers are also due on or before October 31st. The ISSTT mini-special Issue is scheduled for Spring 2015.

Two other special issues are in our planning queue at this time. First, a mini-Special Issue covering selected THz papers from the **2014 Laser Optics Symposium** held in St. Petersburg, Russia, at the end of June (http://www.laseroptics.ru/). This issue is being spearheaded by Topic Editor, Alex Shkurinov (ashkurinov@gmail.com), and Special mini-issue Guest Editor, Jean-Louis Coutaz (University of Savoie, France, jean-louis.coutaz@univ-savoie.fr) and is part of our new Russian initiative. Second, a full special issue that contains specially solicited papers from the upcoming **39th International Conference on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2014)** in Tucson, AZ, USA, in the works. For information, contact Special Issue Editor-in-Chief, Peter Siegel (phs@caltech.edu).

Looking a bit at this month's contributions, we start off with our usual THz Pioneer article, this time covering the career of Professor Michael Bass, who has been affiliated with the University of Central Florida's Center for Research in Electro-Optics and Lasers (CREOL) for more than 25 years. In the same vein as our THz Pioneer subject last issue, Michael Bass needs no introduction in the *optics* community, but may not be as well recognized within the *THz* world. This is due to the fact that his contribution to our community dates back to the late 1960s and it did not get serious attention for almost 40 years. In the meantime Michael found many other interesting things to work on. Nevertheless, I believe the influence of Professor Bass's pioneering work on optical rectification is now so widespread within the THz community, that both he and his many other scientific contributions warrant a closer peek. I think you will find his story both interesting and amusing.

In our July print issue, we have 13 regular paper contributions, and they span a somewhat wider range of topics than we have had of late. I will not go into detail, but you will note some novel experimental work on flowing water films (*Wang, Klarskov, and Jepsen*), and auto paint thickness monitoring (*Su, Shen, and Zeitler*), as well as a nifty phase sensitive detection technique for passive imaging (*Augustin and Hübers*). Papers covering components include two silicon-based waveguide realizations (*Malekabadi et al.*) and (*Li et al.*), a 200 GHz MHEMT low noise amplifier (*Kärkkäinen et al.*), improved photoconducting antennas (*Moreno et al.*) and photomixers (*Khiabani et al.*), and a 670 GHz electron gun design (*Singh, Kumar, and Sinha*). We also have a 557 GHz heterodyne radiometer/spectrometer paper (*Neumaier et al.*) and a paper on optimizing optical parameters for fast 3-D image reconstruction with supporting measurements (*Gu et al.*). Finally, we have a nice experimental paper on ultra broadband THz generation in $LiNiO_3$ (*Nagai et al.*) and a novel method for non-contact wafer probing with demonstration between 220–330 GHz (*Jam et al.*).

I am very pleased to note that the July print issue also includes our first set of targeted "*THz Letters*" submissions. Perhaps not surprisingly, one of these is from the THz group at Nagoya, Japan, on a $LiNiO_3$ based spectrometer (*Murate et al.*) and includes in the author list, our own Topic Editor, Kodo Kawase. Kodo is responsible for suggesting the short paper submission format for this journal at our Reviewers' Reception last September in Mainz, Germany (part of the 38th International Conference on Infrared, Millimeter, and Terahertz Waves). A second "Letters" formatted paper, from the group at University of Virginia (*Bauwens et al.*) on 700–900 wafer probes, illustrates in my view, the ideal type, style and depth of subject matter for such a submission. I encourage other "Letters" writers to follow the two examples in this month's issue.

Now, please turn the page to begin Volume 4, Issue 4 of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

PETER H. SIEGEL, *Editor-in-Chief*
California Institute of Technology and THz Global
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Digital Object Identifier 10.1109/TTHZ.2014.2328934

Peter H. Siegel (S'77–M'83–SM'98–F'01) received the B.A. degree from Colgate University, Hamilton, NY, in 1976, and the Ph.D. degree from Columbia University, New York, in 1983.

He held appointments as Faculty Associate in Electrical Engineering and Senior Scientist in Biology at Caltech, Pasadena, CA, USA, and Senior Research Scientist and Technical Group Supervisor for Submillimeter Wave Advanced Technology (SWAT) at the Jet Propulsion Laboratory (JPL) in Pasadena, CA, USA, for more than 25 years. He retired from these positions in September 2013 in order to focus on a small R&D company he started, THz Global. He is also continuing his affiliation at Caltech as a Visiting Faculty member in the Electrical Engineering Department. He has been working in the areas of millimeter and submillimeter-wave technology and applications for 40 years, and has PI'd or co-I'd more than 75 R&D programs and been involved in four major space flight instruments. He has published more than 300 articles in the THz field, and has given more than 200 invited talks in the U.S. and abroad on this subject. At JPL, he led a group of 25+ research scientists and engineers developing THz technology for NASA's near and long term space missions as well as for several Department of Defense (DoD) applications. At Caltech, he has been involved in new biological and medical applications of THz. His current interests are focused on THz applications in medicine and biology. He is extremely pleased, and very excited to be involved in the formation and launching of the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY. (His Web Pages: http://www.thz.caltech.edu; http://www.irmmw-thz.org; http://www.thz.ieee.org; http://www.thzglobal.com; e-mail: phs@caltech.edu).

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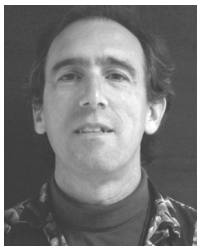

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Dr. Llombart was co-recipient of the H. A. Wheeler Award for the Best Applications Paper of 2008 in the IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION. She was also a co-recipient of an Honorable Mention at the 2010 European Conference of Antennas.

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He is currently a professor of Electrical Engineering at the University of Hawaii, Manoa, HI, USA. From 1998 to 2003, Dr. Lubecke was with Bell Laboratories, Lucent Technologies, where his research focused on remote sensing technologies for biomedical and industrial applications, and on microelectromechanical systems (MEMS) and 3-D wafer-scale integration technologies for wireless and optical communications. From 1987 through 1996, he was with the NASA Jet Propulsion Laboratory (JPL), and from 1996 to 1998, he was with the Institute for Physical and Chemical Research (RIKEN), Sendai, Japan, where his research involved terahertz and MEMS technologies for space remote

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Imran Mehdi (S'83–M'90–SM'09–F'10) received the B.S.E.E. degree in 1985, the M.S.E.E. degree in 1986, and the Ph.D. degree in 1990, all from the University of Michigan.

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Alexander Shkurinov graduated in 1985 with honors from the Department of Physics of M.V. Lomonosov Moscow State University (MSU), and received the Ph.D. degree in physics from MSU in 1988.

In 1989, he became Research Scientist at the R.V. Khohlov Laboratory of Non-Linear Optics at MSU. His research interests are centered on the development and application of femtosecond laser techniques, time-resolved spectroscopy of molecules in the liquid phase, nonlinear optics and terahertz techniques and spectroscopy.

Dr. Shkurinov has participated in a wide range of scientific advisory boards and sat on the organizing and program committees of numerous international conferences. He was awarded the Rozhdestvensky Medal from the Russian Optical Society for his contribution into the development of optical science and technology in 2008.

Jan Stake (M'95) received the M.Sc. degree in electrical engineering and Ph.D. degree in microwave electronics from Chalmers University of Technology, Göteborg, Sweden, in 1994 and 1999, respectively.

In 1997, he was a Research Assistant at the University of Virginia, Charlottesville, VA, USA. From 1999 to 2001, he was a Research Fellow in the millimeter wave group at the Rutherford Appleton Laboratory, U.K. He then joined Saab Combitech Systems AB as a Senior RF/microwave Engineer until 2003. From 2000 to 2006, he held different academic positions at Chalmers and was also Head of the Nanofabrication Laboratory at MC2 between 2003 and 2006. During 2007, he was a Visiting Professor in the Submillimeter Wave Advanced Technology (SWAT) group at Caltech/JPL, exploring THz applications in biology and medicine. He is currently Professor and Head of the Terahertz and Millimetre Wave Laboratory, Chalmers, Sweden. His research involves terahertz sources, detectors and mixers, high frequency semiconductor devices, graphene electronics, terahertz measurement techniques and applications.

Christopher Walker has over 25 years experience designing, building, and using state-of-the-art receiver systems for THz astronomy. He is a Professor of Astronomy and an Associate Professor of Optical Sciences and Electrical Engineering at the University of Arizona (U of A). He has worked in industry (TRW Aerospace and JPL) as well as academia. As a Millikan Fellow in Physics at Caltech, he worked on the development of low-noise, SIS waveguide receivers above 400 GHz and explored techniques for etching waveguide out of silicon. On joining the U of A faculty in 1991 he began the Steward Observatory Radio Astronomy Lab (SORAL), which has become a world leader in developing THz receiver systems for astronomy and other remote sensing applications. These instruments are multi-institutional efforts, with key components coming from JPL, several universities, and a number of industrial partners. He manages and coordinates these efforts. Instruments developed by Prof. Walker's team have served as primary facility instruments at the Heinrich Hertz Telescope on Mt. Graham, AZ, USA, and the AST/RO telescope at the South Pole. He is leading the effort to design and build the world's largest (64 pixels) submillimeter-wave heterodyne array receiver (SuperCam). He is also PI of the NASA funded long duration balloon project "The Stratospheric THz Observatory (STO)". He has published numerous papers on star formation and protostellar evolution. He has served as dissertation director for nine Ph.D. students.

Vincent Wallace received the Ph.D. degree in medical physics from the University of London, London, U.K., in 1997.

He has nearly 20 years of experience in Biophotonics. After four years as a post doctorate at the Beckman Laser Institute and Medical Clinic, University of California, Irvine, CA, USA he joined Toshiba Research in Cambridge, U.K., to look at potential applications of terahertz radiation. The terahertz group was spun-out of Toshiba Labs in April 2001 and became TeraView Ltd, also based in Cambridge. At TeraView, he led a group investigation the biomedical applications of terahertz technology. In 2007, he moved to the University of Western Australia to take up a full time academic role where he continues to apply terahertz and other optical techniques to biomedical and clinical problems and the understanding of the interaction of electromagnetic radiation with tissues.

Editorial

Post Production Notice: Just after turning in this Editorial we received notification of our first Journal Citation Report ranking from Thomson Reuters. I am extremely pleased to report that our 2013 Impact Factor stands at 4.34, placing us 12th out of 247 journals in Electrical Engineering. We also placed 17th out of 136 in Applied Physics, and 5th out of 82 in Optics, the two other categories we were rated under. A very hearty thank you to all our contributors, who took a chance on our new venture to better serve the THz community.

I SINCERELY hope all of you have had a wonderful Summer, and are now looking ahead to a productive Fall. If our planning was on track, many of you will be reading this as you attend the **39th International Conference on Infrared, Millimeter, and Terahertz Waves** in Tucson, AZ, USA. I hope I will meet you there. If you are keeping count, this issue represents a small personal milestone, in that it begins our fourth year of print releases, having started with vol. 1, no. 1, in September 2011, which now seems a long time ago!

The September 2014 issue, like our July release, contains only regularly contributed papers. We bring you 12 standard length articles and two **THz Letters** submissions. This month's *THz Pioneer* article is on the career of Swedish engineer and astronomer, Professor Erik Kollberg, at Chalmers University of Technology, Goteborg, Sweden. Erik is among the first group of RF engineers who were able to establish long term professional careers in support of radio astronomy instruments, without specializing in observations themselves. In Kollberg's case, it was the Onsala Space Observatory, Onsala, Sweden, for which he developed maser, and later solid-state electronics-based low-noise receivers, amongst his many other achievements.

Our regular contributions this month appropriately begin with low-noise mixer developments from radio instrumentation groups at JPL, Pasadena, CA, USA (*Boussaha, Kawamura, Stern, and Jung*) and from Aalto University, Helsinki, Finland (*Dahlberg, Kiuru, Mallat, Narhi, and Räisänen*). These are followed by a nice application article using THz spectroscopy to quantify silicon photovoltaic wafers from a team at Rochester Institute of Technology, USA (*Jen and Richter*).

A second article from Aalto University (*Generalov, Haimakainen, Lioubtchenko and Räisänen*) presents the detailed design, analysis, and supporting measurements on a submillimeter-wave deployable dielectric rod antenna with excellent bandwidth.

A major gain in optical-to-terahertz photoconductive emitter efficiency ($>7\%$) was achieved, and is reported this month by the group at UCLA, USA (*Yang, Hashemi, Berry and Jarrahi*). This should have a very positive impact on both time domain systems and CW photomixers.

The RF electronics group from Chalmers, and former graduate student of Erik Kollberg, Jan Stake, have some advice for making high accuracy S-parameter measurements in the THz regime (*Hanning, Stenarson, Yhland, Sobis, Bryllert, and Stake*). In keeping with the radio astronomy theme this month, we carry an article on APEX (Atacama Pathfinder Experiment), the 12 meter diameter radio dish located at the 5100 m high Atacama, Chile observatory site along with ALMA (Atacama Large Millimeter Array)[1] from the group (*Klein*, *et al.*) at Max Planck Institute for Radioastronomy, Bonn, Germany, NAO, Tokyo, Japan, and the European Southern Observatory.

Moreno and Grajal (Technical University of Madrid) contribute an article on high frequency thermal effects in Schottky diodes with validation on millimeter-wave devices. This is followed by a methods paper for enhancing time-domain signal amplitude with a new type of modulation (*Schneider*) from ETH Zurich, Switzerland.

An article from University of Victoria, Canada, describes a reconfigurable THz communications array and predicts parameters for path loss and channel capacity for indoor use (*Xu, Dong and Boornemann*).

Finally, we present two papers on biological applications of millimeter and submillimeter-wave techniques from the well-known group at Hebrew University, Jerusalem, Israel (*Kurzweil-Segev, Brodsky, Polsman, Safrai, Feldman, Einav, and Ben Ishai*) and (*Safrai, Ben Ishai, Polsman, Einav, and Feldman*).

In our **THz Letters** section, there two compact papers, one on quantum cascade lasers from the lovely town of Bari and Pisa, Italy, in collaboration with Cavendish Labs, Cambridge, U.K. (*Mezzapesa, Petruzzella, Dabbicco, Beere, Ritchie, Vitiello, and Scamarcio*), and a second nice result on a very broadband orthomode transducer for waveguide applications from a team in Madrid, Spain and at JPL, Pasadena, California, USA (*Leal-Sevillano, Reck, Chattopadhyay, Ruiz-Cruz, Montejo-Garai, and Rebollar*).

This concludes our selections for the September 2014 issue. We have a long list of papers in our reviewer queue at the moment and expect to have a somewhat thick end-of-year print issue coming up for November.

A reminder that the deadline for submitting papers to our **Terahertz Nanomaterials and Applications** issue is coming up quickly—October 31st. Please contact our Special Issue Guest Editor-in-Chief, Goutam Chattopad-

[1]See a description in: "THz Pioneer: Mattheus (Thijs) de Graauw—Intention, Attention, Execution," *IEEE Trans. THz Sci. Technol.*, vol. 4, no. 2, pp. 137–146, Mar. 2014.

Digital Object Identifier 10.1109/TTHZ.2014.2343532

hyay, if you have questions or concerns: goutam.chattopadhyay@jpl.nasa.gov. Also expanded papers from the 2014 **International Symposium on Space Terahertz Technology (ISSTT)** are due at the same time. Please contact Gregory Gol'tsman (goltsman@mspu-phys.ru) or Imran Mehdi (Imran.mehdi@jpl.nasa.gov) if you are planning to contribute *Authors, please remember to select Special Issue paper when you submit your manuscript to either of these two targeted releases*.

Now, please turn the page to begin Volume 4, Issue 5 of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

PETER H. SIEGEL, *Editor-in-Chief*
California Institute of Technology and THz Global
Pasadena, CA USA

Peter H. Siegel (S'77–M'83–SM'98–F'01) received the B.A. degree from Colgate University, Hamilton, NY, in 1976, and the Ph.D. degree from Columbia University, New York, in 1983.

He held appointments as Faculty Associate in Electrical Engineering and Senior Scientist in Biology at Caltech, Pasadena, CA, USA, and Senior Research Scientist and Technical Group Supervisor for Submillimeter Wave Advanced Technology (SWAT) at the Jet Propulsion Laboratory (JPL) in Pasadena, CA, USA, for more than 25 years. He retired from these positions in September 2013 in order to focus on a small R&D company he started, THz Global. He is also continuing his affiliation at Caltech as a Visiting Faculty member in the Electrical Engineering Department. He has been working in the areas of millimeter and submillimeter-wave technology and applications for 40 years, and has PI'd or co-I'd more than 75 R&D programs and been involved in four major space flight instruments. He has published more than 300 articles in the THz field, and has given more than 200 invited talks in the U.S. and abroad on this subject. At JPL, he led a group of 25+ research scientists and engineers developing THz technology for NASA's near and long term space missions as well as for several Department of Defense (DoD) applications. At Caltech, he has been involved in new biological and medical applications of THz. His current interests are focused on THz applications in medicine and biology. He is extremely pleased, and very excited to be involved in the formation and launching of the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY. (His Web Pages: http://www.thz.caltech.edu; http://www.irmmw-thz.org; http://www.thz.ieee.org; http://www.thzglobal.com; e-mail: phs@caltech.edu).

Among many other duties, Dr. Siegel serves as elected General Secretary of the International Society for Infrared, Millimeter, and Terahertz Waves (IRMMW-THz), the oldest and largest venue devoted to the field of far IR techniques, science and applications, and he served as conference organizer and chair for IRMMW-THz 2008 in Pasadena and IRMMW-THz 2014 in Tucson, AZ. He also founded, incorporated and served as first President of the International Society of Infrared, Millimeter, and Terahertz Waves. He served as an IEEE Distinguished Microwave Lecturer, co-Chair and Chair of MTT Committee 4—THz Technology, a TPC and Speaker's bureau member, and as organizer and chair of seven special sessions at the IEEE International Microwave Symposia.

ADMINISTRATIVE EDITOR

Sharri Shaw was born in Michigan, and currently resides in Boulder, CO. She received the B.A. degree in english and a minor in psychology, from Saginaw Valley State University, in 1994. She continued her studies in 2001 in the Master in Education with Initial Certification (M.Ed.) program at Aquinas College, where she received her Secondary Level Teacher Certification.

From 2002 to 2005, she was a teacher in Michigan. From 2006 to 2010, she was the Assistant Editor of the IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES. She currently holds the same position with *IEEE Microwave Magazine*, and also serves as the Publications Administrator for the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

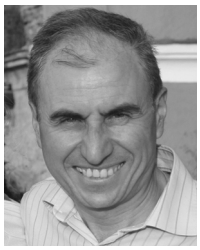
TOPIC EDITORS

René Beigang received the Diploma and Ph.D. degrees from the University of Hannover, Hannover, Germany.

He spent three years as a post-doctorate and visiting scientist at the IBM T. J. Watson Research Center, Yorktown Heights, NY. He was Associate Professor at the Free University of Berlin and the University of Kaiserslautern. He is now a full professor at the Department of Physics of the University of Kaiserslautern. Since 2005, he is also Head of the Department on Terahertz Measurement and Systems of the Fraunhofer Institute for Physical Measurement Techniques. His current research interests include nonlinear optics, generation and application of THz radiation, THz spectroscopy, applications of THz radiation in science and technology, realization and investigation of THz meta materials. (His homepage: http://www.physik.uni-kl.de/beigang).

A. Giles Davies received the B.Sc. degree in chemical physics from the University of Bristol, Bristol, U.K., in 1987, and the Ph.D. degree in semiconductor physics from the University of Cambridge, Cambridge, U.K., in 1991.

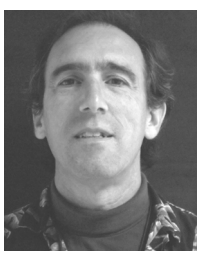
He is currently Professor of Electronic and Photonic Engineering at the University of Leeds, Leeds, U.K. His research interests concentrate on the electrical and optical properties of low-dimensional and nanostructured electronic systems, and multilayered semiconductor devices, with particular recent focus on the development of terahertz frequency systems and the exploitation of biological processes for nanoscale assembly.



Gian Piero Gallerano received the Laurea Degree (Ph.D.) in physics from the University of Rome, Italy, in 1980 with a thesis on the realization of a tunable color center laser in the near infrared.

In 1981, he was a Visiting Fellow at the Technical University Hannover, Germany. In 1983 he joined the High Power Laser Laboratory at ENEA Research Center, Frascati to work on the development of infrared free electron lasers (FEL). In 1991, he was a Visiting Scholar at the Ginzton Laboratory, EE Department, Stanford University. His work on FELs lead to the realization of the ENEA Compact FEL (90–150 GHz) and of the Compact Advanced THz Source, FEL-CATS (0.4–0.7 THz). From 2001 to 2004, he has been the Coordinator of the European project THz-BRIDGE involving ten research institutes in the study the interaction of THz radiation with biological systems. From 2005 to 2007, he was in charge of the ENEA participation in the European project EUROFEL. He is currently the Head of the Radiation Sources Laboratory at ENEA Frascati. His areas of interest include generation of THz radiation and its application in the biological, biomedical, environmental and art conservation fields, THz imaging techniques, coherent emission from RF modulated electron beams, free electron lasers, optical design and diagnostics in the infrared.

Dr. Gallerano organized the "35th International Conference on Infrared, Millimeter and THz Waves" IRMMW-THz 2010 held in Rome, Italy, September 5–10, 2010, and currently chairs the International Society of Infrared, Millimeter and Terahertz Waves, the oldest and largest forum devoted to scientific and technological developments in the wide spectral range extending from the infrared to the millimeter wave region. He has been a member of the Italian Physical Society since 1981, and is a member of the Bioelectromagnetics Society.



Erich N. Grossman received the A.B. degree in physics from Harvard College, Cambridge, MA, in 1980, and a Ph.D. degree, also in physics, from the California Institute of Technology, Pasadena, in 1987. His thesis work involved development of an ultra-low noise, heterodyne receiver for 2 THz astronomy.

From 1988 to 1989, he was a post-doctoral fellow at the University of Texas at Austin, TX, USA, and in 1989, he joined the National Institute of Standards and Technology, Boulder, CO, USA, where he is now a physicist in the Optoelectronics Division. His work at NIST focuses on infrared and submillimeter system development.

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He is currently Principal Member of Engineering staff at the Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA, and Supervisor of the JPL Submillimeter-Wave advanced Technology (SWAT) team. His responsibilities include developing THz components and subsystems for current and future NASA missions. He joined JPL in 1990 where his first task included the design and fabrication of low-parasitic planar Schottky diodes for submillimeter-wave applications. These devices were implemented on the ozone monitoring Microwave Limb Sounder instrument launched in 2004, as well as the MIRO instrument which represents the first submillimeter-wave receiver that will rendezvous with a comet in 2014. From 1999, he led the effort of developing broadband solid-state sources from 200 to 2500 GHz for the Heterodyne Instrument for Far Infrared (HIFI) on the Herschel Space Observatory, a cornerstone European Space Agency mission currently in space. This effort led to realization of wide-band solid-state sources in the THz range enabling ground-breaking astrophysics observations in space as well as at many ground-based observatories. His current interests include both mm and sub-mm wave devices, semiconductor fabrication technology, high-frequency instrumentation, and heterodyne receivers for miniature systems.

Alexander Shkurinov graduated in 1985 with honors from the Department of Physics of M.V. Lomonosov Moscow State University (MSU), and received the Ph.D. degree in physics from MSU in 1988.

In 1989, he became Research Scientist at the R.V. Khohlov Laboratory of Non-Linear Optics at MSU. His research interests are centered on the development and application of femtosecond laser techniques, time-resolved spectroscopy of molecules in the liquid phase, nonlinear optics and terahertz techniques and spectroscopy.

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Jan Stake (M'95) received the M.Sc. degree in electrical engineering and Ph.D. degree in microwave electronics from Chalmers University of Technology, Göteborg, Sweden, in 1994 and 1999, respectively.

In 1997, he was a Research Assistant at the University of Virginia, Charlottesville, VA, USA. From 1999 to 2001, he was a Research Fellow in the millimeter wave group at the Rutherford Appleton Laboratory, U.K. He then joined Saab Combitech Systems AB as a Senior RF/microwave Engineer until 2003. From 2000 to 2006, he held different academic positions at Chalmers and was also Head of the Nanofabrication Laboratory at MC2 between 2003 and 2006. During 2007, he was a Visiting Professor in the Submillimeter Wave Advanced Technology (SWAT) group at Caltech/JPL, exploring THz applications in biology and medicine. He is currently Professor and Head of the Terahertz and Millimetre Wave Laboratory, Chalmers, Sweden. His research involves terahertz sources, detectors and mixers, high frequency semiconductor devices, graphene electronics, terahertz measurement techniques and applications.

Christopher Walker has over 25 years experience designing, building, and using state-of-the-art receiver systems for THz astronomy. He is a Professor of Astronomy and an Associate Professor of Optical Sciences and Electrical Engineering at the University of Arizona (U of A). He has worked in industry (TRW Aerospace and JPL) as well as academia. As a Millikan Fellow in Physics at Caltech, he worked on the development of low-noise, SIS waveguide receivers above 400 GHz and explored techniques for etching waveguide out of silicon. On joining the U of A faculty in 1991 he began the Steward Observatory Radio Astronomy Lab (SORAL), which has become a world leader in developing THz receiver systems for astronomy and other remote sensing applications. These instruments are multi-institutional efforts, with key components coming from JPL, several universities, and a number of industrial partners. He manages and coordinates these efforts. Instruments developed by Prof. Walker's team have served as primary facility instruments at the Heinrich Hertz Telescope on Mt. Graham, AZ, USA, and the AST/RO telescope at the South Pole. He is leading the effort to design and build the world's largest (64 pixels) submillimeter-wave heterodyne array receiver (SuperCam). He is also PI of the NASA funded long duration balloon project "The Stratospheric THz Observatory (STO)". He has published numerous papers on star formation and protostellar evolution. He has served as dissertation director for nine Ph.D. students.

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Editorial

AS OUR TWENTIETH print issue comes to a close, together with our third full year of production, we have a lot to be thankful for and a lot for which to be proud. For those of you who have responded positively to our appeals, who took a chance on putting your research work into a new journal with no official ranking and, at best, an uncertain future, your gamble has paid off nicely. For those of you who have supported us from the beginning, from way back in 2011, and who have stood with us for the last three years, repeatedly submitting papers, I believe your loyalty has been duly rewarded. As you know, the Thomson Reuters Journal Citation Report for 2013 has ranked these Transactions (based on our Impact Factor of 4.35) in the top 5% of all electrical engineering journals (12th out of 247) and 17th out of 136 journals in Applied Physics. We were also ranked in the category of Optics, and placed 5th out of 82 of the journals on this list.

We could not have got to this point without the full support and continuous encouragement of our founding organization, the *IEEE Microwave Theory and Techniques Society* (MTT-S), and the current, and five former Presidents of the MTT-S Administrative Committee who conceived, pushed through, funded, and continuously fortified this journal throughout its formative years. Infinite thanks to Samir El Ghazaly, Dick Snyder, Nick Kolias, Madhu Gupta, Robert Weigel, and Tim Lee. Also a truly special thanks to Mike Golio, Joy Laskar, and Mark Gouker, for many hours of helpful discussion and hands-on assistance with everything from surveys, to advertising, to web site production and maintenance, to finances. The largest measure of credit and gratitude has to go to Dylan Williams, who not only worked tirelessly to take this journal from proposal to reality, but who also devoted three years to us as Executive Editor, bringing considerable experience and advice, and helping to shepherd us through the inevitable growing pains, and administrative hurdles that had to be overcome in order for the journal to stand fully on its own. Finally, our Administrative Editor, Sharri Shaw and all of our Topic Editors—most of whom are still with me after 4 long years (we just completed our 50th meeting!), have really gone above and beyond, to assure that we have served the THz community with quality, innovation, and fairness. My heartfelt thanks for your devotion and service.

Moving forward, we plan to continue with our focus on personal attention to authors, relevance to our readers, and a significantly increased standard of excellence in our selection of manuscripts. Starting immediately, but not manifested until after our January 2015 print issue, we will be accepting papers through a two-step process. All incoming manuscripts will be pre-screened by a panel of at least three independent editors, before being sent on for peer review. Authors will be notified immediately, if their submission is deemed not ready or not consistent with our criteria for continuation on to the second step of the review process. The details of the screening process and the compliance features are listed on our web site, and will be reproduced in this and future print issues of this journal. Please look closely at the submission criteria before submitting a manuscript, and if you have any questions, contact the Editor-in-Chief directly.

This month we finish up Volume 4 with a modest selection of Regular Papers and Letters covering devices, antennas, spectroscopy applications, and imaging. Our THz Pioneer article is on the career of Schottky diode fabricator extraordinaire, Robert J. Mattauch, whose custom-made two-terminal millimeter- and submillimeter-wave devices were an integral part of the instruments that helped to make the careers of many of the individuals who have appeared in this series of articles and many of us who have worked in the RF THz field since the days before commercial components could be purchased.

For those of you attended our Reviewer's reception at the **39th International Conference on Infrared, Millimeter, and Terahertz Waves** in Tucson, Arizona, USA, this past September, I would like to thank you again for your enthusiasm, your advice, and your continued support of this journal. I hope to see you all again, as well as some new faces next year in Hong Kong at the 40th conference in this long running series.

I will close on that note, so you can get right to our first article in Volume 4, Issue 6, of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY. Thank you all for your continued support.

PETER H. SIEGEL, *Editor-in-Chief*
California Institute of Technology and THz Global
Pasadena, CA USA

Peter H. Siegel (S'77–M'83–SM'98–F'01) received the B.A. degree from Colgate University, Hamilton, NY, in 1976, and the Ph.D. degree from Columbia University, New York, in 1983.

He held appointments as Faculty Associate in Electrical Engineering and Senior Scientist in Biology at Caltech, Pasadena, CA, USA, and Senior Research Scientist and Technical Group Supervisor for Submillimeter Wave Advanced Technology (SWAT) at the Jet Propulsion Laboratory (JPL) in Pasadena, CA, USA, for more than 25 years. He retired from these positions in September 2013 in order to focus on a small R&D company he started, THz Global. He is also continuing his affiliation at Caltech as a Visiting Faculty member in the Electrical Engineering Department. He has been working in the areas of millimeter and submillimeter-wave technology and applications for 40 years, and has PI'd or co-I'd more than 75 R&D programs and been involved in four major space flight instruments. He has published more than 300 articles in the THz field, and has given more than 200 invited talks in the U.S. and abroad on this subject. At JPL, he led a group of 25+ research scientists and engineers developing THz technology for NASA's near and long term space missions as well as for several Department of Defense (DoD) applications. At Caltech, he has been involved

Digital Object Identifier 10.1109/TTHZ.2014.2361160

in new biological and medical applications of THz. His current interests are focused on THz applications in medicine and biology. He is extremely pleased, and very excited to be involved in the formation and launching of the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY. (His Web Pages: http://www.thz.caltech.edu; http://www.irmmw-thz.org; http://www.thz.ieee.org; http://www.thzglobal.com; e-mail: phs@caltech.edu).

Among many other duties, Dr. Siegel serves as elected General Secretary of the International Society for Infrared, Millimeter, and Terahertz Waves (IRMMW-THz), the oldest and largest venue devoted to the field of far IR techniques, science and applications, and he served as conference organizer and chair for IRMMW-THz 2008 in Pasadena and IRMMW-THz 2014 in Tucson, AZ. He also founded, incorporated and served as first President of the International Society of Infrared, Millimeter, and Terahertz Waves. He served as an IEEE Distinguished Microwave Lecturer, co-Chair and Chair of MTT Committee 4—THz Technology, a TPC and Speaker's bureau member, and as organizer and chair of seven special sessions at the IEEE International Microwave Symposia.

ADMINISTRATIVE EDITOR

Sharri Shaw was born in Michigan, and currently resides in Boulder, CO. She received the B.A. degree in english and a minor in psychology, from Saginaw Valley State University, in 1994. She continued her studies in 2001 in the Master in Education with Initial Certification (M.Ed.) program at Aquinas College, where she received her Secondary Level Teacher Certification.

From 2002 to 2005, she was a teacher in Michigan. From 2006 to 2010, she was the Assistant Editor of the IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES. She currently holds the same position with *IEEE Microwave Magazine*, and also serves as the Publications Administrator for the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

TOPIC EDITORS

René Beigang received the Diploma and Ph.D. degrees from the University of Hannover, Hannover, Germany.

He spent three years as a post-doctorate and visiting scientist at the IBM T. J. Watson Research Center, Yorktown Heights, NY. He was Associate Professor at the Free University of Berlin and the University of Kaiserslautern. He is now a full professor at the Department of Physics of the University of Kaiserslautern. Since 2005, he is also Head of the Department on Terahertz Measurement and Systems of the Fraunhofer Institute for Physical Measurement Techniques. His current research interests include nonlinear optics, generation and application of THz radiation, THz spectroscopy, applications of THz radiation in science and technology, realization and investigation of THz meta materials. (His homepage: http://www.physik.uni-kl.de/beigang).

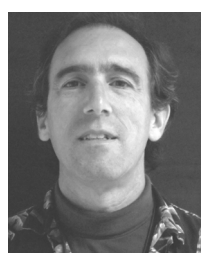
A. Giles Davies received the B.Sc. degree in chemical physics from the University of Bristol, Bristol, U.K., in 1987, and the Ph.D. degree in semiconductor physics from the University of Cambridge, Cambridge, U.K., in 1991.

He is currently Professor of Electronic and Photonic Engineering at the University of Leeds, Leeds, U.K. His research interests concentrate on the electrical and optical properties of low-dimensional and nanostructured electronic systems, and multilayered semiconductor devices, with particular recent focus on the development of terahertz frequency systems and the exploitation of biological processes for nanoscale assembly.

Gian Piero Gallerano received the Laurea Degree (Ph.D.) in physics from the University of Rome, Italy, in 1980 with a thesis on the realization of a tunable color center laser in the near infrared.

In 1981, he was a Visiting Fellow at the Technical University Hannover, Germany. In 1983 he joined the High Power Laser Laboratory at ENEA Research Center, Frascati to work on the development of infrared free electron lasers (FEL). In 1991, he was a Visiting Scholar at the Ginzton Laboratory, EE Department, Stanford University. His work on FELs lead to the realization of the ENEA Compact FEL (90–150 GHz) and of the Compact Advanced THz Source, FEL-CATS (0.4–0.7 THz). From 2001 to 2004, he has been the Coordinator of the European project THz-BRIDGE involving ten research institutes in the study the interaction of THz radiation with biological systems. From 2005 to 2007, he was in charge of the ENEA participation in the European project EUROFEL. He is currently the Head of the Radiation Sources Laboratory at ENEA Frascati. His areas of interest include generation of THz radiation and its application in the biological, biomedical, environmental and art conservation fields, THz imaging techniques, coherent emission from RF modulated electron beams, free electron lasers, optical design and diagnostics in the infrared.

Dr. Gallerano organized the "35th International Conference on Infrared, Millimeter and THz Waves" IRMMW-THz 2010 held in Rome, Italy, September 5–10, 2010, and currently chairs the International Society of Infrared, Millimeter and Terahertz Waves, the oldest and largest forum devoted to scientific and technological developments in the wide spectral range extending from the infrared to the millimeter wave region. He has been a member of the Italian Physical Society since 1981, and is a member of the Bioelectromagnetics Society.



Erich N. Grossman received the A.B. degree in physics from Harvard College, Cambridge, MA, in 1980, and a Ph.D. degree, also in physics, from the California Institute of Technology, Pasadena, in 1987. His thesis work involved development of an ultra-low noise, heterodyne receiver for 2 THz astronomy.

From 1988 to 1989, he was a post-doctoral fellow at the University of Texas at Austin, TX, USA, and in 1989, he joined the National Institute of Standards and Technology, Boulder, CO, USA, where he is now a physicist in the Optoelectronics Division. His work at NIST focuses on infrared and submillimeter system development.

Dr. Grossman's notable accomplishments include the development and demonstration of the world's highest frequency, high efficiency lithographic antennas, the world's highest frequency Josephson junctions, (awarded a Department of Commerce Gold Medal in 1993), and early conception and development of the SQUID multiplexer, first enabling large monolithic arrays of superconducting detectors. More recently, he has developed several 0.1–1 THz cameras for security applications. He is also chair of the Metrology Working Group for the DARPA Terahertz Electronics program.

Haewook Han (M'12) received the B.S. and M.S. degrees in electrical engineering from Seoul National University, Seoul, Korea, in 1986 and 1988, respectively, and the Ph.D. degree in electrical engineering from the University of Illinois at Urbana-Champaign, Urbana, IL, USA, in 1995.

He studied low-threshold strained quantum-well heterostructure lasers and two-dimensional photonic crystal semiconductor lasers. At Bell Laboratories, Murray Hill, NJ, USA, from 1995 to 1997, he contributed to the development of 980-nm high-power semiconductor lasers. He is currently Associate Professor of the Department of Electrical and Computer Engineering at the Pohang University of Science and Technology (POSTECH). He co-founded the Korea THz Forum, and served as the Director of the Center for THz Photonics (1998–2000) and the National Laboratory for Nano-THz Photonics (2005–2009). He invented THz plastic photonic crystal fibers for single-mode THz pulse transmission in 2001. His current research interests include THz hydration dynamics of biomolecules, THz quantum interactions, and THz near-field microscopy and spectroscopy.

Peter Uhd Jepsen (M'10) received the M.Sc. degree in physics and chemistry from Odense University, Denmark, in 1994, and the Ph.D. degree in natural sciences from Århus University, Denmark in 1996.

He was at the University of Freiburg, Germany from 1996 to 2004, working with terahertz time-domain spectroscopy. From 2005, he was Associate Professor at the Technical University of Denmark (DTU), and since 2008, Professor and Head of the Terahertz Technologies and Biophotonics group at DTU. In 2008/2009, he was Visiting Professor at Osaka University. His research areas include photonics-based THz technology, broadband THz spectroscopy for chemical sensing, imaging, chemistry, and water dynamics in the THz range, and time-resolved THz spectroscopy of ultrafast phenomena in the THz range.

Kodo Kawase received the B.S. degree in electronic engineering from Kyoto University in 1989, Japan, and the Ph.D. degree in electronic engineering from Tohoku University, Japan, in 1996.

He became an Initiative Researcher at RIKEN in 2001 and a Professor in the Graduate School of Engineering, Nagoya University, Japan, in 2005. He has been conducting research activities in several directions within the THz field. Professor Kawase developed several types of widely tunable THz sources using nonlinear optical effects, and implemented them for a wide range of real-life applications. He has published more than 130 articles in the THz field and has given more than 160 invited talks on this subject.

Dr. Kawase received the 1997 Young Scientist Award from the JSAP, the 1998 Excellent Presentation Award, the 2000 and 2006 Prize of Laser Engineering from the Laser Society of Japan, the 2002 Marubun research and encouragement award and the 2006 Marubun Special Research Award from the Marubun Research Promotion Foundation (MRPF), and the 2005 Young Scientists' Prize by the Commendation for Science and Technology of the Minister of Education, Culture, Science and Technology (MEXT).

Nuria Llombart received the Electrical Engineering degree and Ph.D. degree from the Polytechnic University of Valencia, Spain, in 2002 and 2006, respectively.

During her Masters' degree studies she spent one year at the Friedrich-Alexander University of Erlangen-Nuremberg, Germany, and worked at the Fraunhofer Institute for Integrated Circuits, Erlangen, Germany. From 2002 until 2007, she was with the Antenna Group at the TNO Defence, Security and Safety Institute, The Hague, The Netherlands, working as Ph.D. student and afterwards as a researcher. From 2007 until 2010, she was a Post-Doctoral Fellow at the California Institute of Technology, working for the Sub millimeter Wave Advance Technology group of the Jet Propulsion Laboratory (JPL), Pasadena, CA, USA. From 2010 to 2012, she held a "Ramón y Cajal" fellowship at the Optics Department of the Complutense University of Madrid, Spain. She recently relocated to Technical University of Delft, Netherlands, where she is a professor in the Electrical Engineering department, and she continues to be an affiliate at JPL, Pasadena. Her research interests include the analysis and design of planar antennas, periodic structures, reflector antennas, lens antennas, waveguide structures, with emphasis in the THz range.

Dr. Llombart was co-recipient of the H. A. Wheeler Award for the Best Applications Paper of 2008 in the IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION. She was also a co-recipient of an Honorable Mention at the 2010 European Conference of Antennas.

Victor M. Lubecke received the B.S.E.E. degree from the California State Polytechnic Institute, Pomona, CA, USA, in 1986, and the M.S. and Ph.D. degrees in electrical engineering from the California Institute of Technology, Pasadena, CA, USA, in 1990 and 1995, respectively.

He is currently a professor of Electrical Engineering at the University of Hawaii, Manoa, HI, USA. From 1998 to 2003, Dr. Lubecke was with Bell Laboratories, Lucent Technologies, where his research focused on remote sensing technologies for biomedical and industrial applications, and on microelectromechanical systems (MEMS) and 3-D wafer-scale integration technologies for wireless and optical communications. From 1987 through 1996, he was with the NASA Jet Propulsion Laboratory (JPL), and from 1996 to 1998, he was with the Institute for Physical and Chemical Research (RIKEN), Sendai, Japan, where his research involved terahertz and MEMS technologies for space remote sensing and communications applications. He holds 6 U.S. patents with several pending, and has published over 150 peer-reviewed research articles.

Prof. Lubecke is an emeritus Distinguished Microwave Lecturer (2006–2008) of the IEEE Microwave Theory and Techniques Society, and was co-recipient of the Emerging Technology Award at TechConnect 2007. He co-founded and served as CTO for a start-up company that is now Kai Medical, Honolulu, HI. His current research interests include remote sensing technologies, biomedical sensors, MEMS, heterogeneous integration, and microwave/terahertz radio.

Imran Mehdi (S'83–M'90–SM'09–F'10) received the B.S.E.E. degree in 1985, the M.S.E.E. degree in 1986, and the Ph.D. degree in 1990, all from the University of Michigan.

He is currently Principal Member of Engineering staff at the Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA, and Supervisor of the JPL Submillimeter-Wave advanced Technology (SWAT) team. His responsibilities include developing THz components and subsystems for current and future NASA missions. He joined JPL in 1990 where his first task included the design and fabrication of low-parasitic planar Schottky diodes for submillimeter-wave applications.

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Editorial

WE BEGIN the new year with Volume 5, *the fourth full year of this* TRANSACTIONS. In 2015, plans include several firsts, as well as several old standbys.

This month we present our fourth consecutive-year Mini-Special Issue containing expanded papers from the International Symposium on Space Terahertz Technology (ISSTT). This long running THz symposium held its 25th international meeting in Moscow, Russia, this past April 27–30th, 2014. We are carrying eight papers from the conference with an introduction from Guest Editors Gregory Golts'man (Moscow State Pedagogical University and conference Chair), Patrick Pütz (Universität zu Köln, Germany), and our own, Imran Mehdi. ISSTT represents a small, but unique application area within the THz community, and provides one of the few outlets for presenting progress on ultra-low noise receiver and narrow-band CW source technology (that often spills over into other fields). Several of the papers in this year's special mini-issue will find relevance in the broader THz community, particularly, *Karasik et al.* on nanobolometers and *Ustinov et al.* on tunable superconducting metamaterials. Other articles cover SIS mixers (*Navarrini et al.*), THz bolometric arrays (*Mahashabde et al.* as well as *Tarasov et al.*), working with cold optics for the most stringent low-noise applications (*Sekiguchi et al.*) and radio telescope design (*Imada et al.*) and placement (*Bubnov et al.*).

We also have a dedicated special issue on *Terahertz RF Nanomaterials and Applications* in the works, which we expect to publish this May. Goutam Chattopadhyay (Jet Propulsion Laboratory, USA), Luca Pierantoni (Universita Politechnica delle Marche, Italy), Thomas Mitchell Wallis (NIST, Boulder, USA), Fabio Coccetti (CNRS, France) and Imran Mehdi (JPL, USA) have been collecting invited and contributed papers for this issue.

Also, new for 2015 is a mini-issue with expanded papers from special THz sessions at the *16th International Conference on Laser Optics*, held in St. Petersburg, Russia, this past summer. We hope to have this mini-issue in print for July 2015. This special issue was stimulated, in part, by our efforts to better serve the strong THz community that is active in Russia and neighboring states, but which publishes mainly in Russian language journals. Our own Topic Editor, Alex Shkurinov (Moscow State University), and Jean Louis Coutaz (University of Savoy) are putting this mini-issue together now.

In another first for these *THz Transactions* we are teaming with the **Institute of Electronics, Information and Communications Engineers** (IEICE) in Japan, to potentially release a Special Supplemental issue this spring containing selected translated papers from the *IEICE Special Issue on Advanced Terahertz Technologies and Efforts Towards Practical Realizations, vol. 97, no. 11,* that was released in November 2014. These papers are deemed to be of particular interest to the broader THz community because of their focus on application areas. IEICE Special Issue authors, Naoya Kukutsu (ATR Wave Engineering Laboratories), and Tadao Nagatsuma (Osaka University), are joining with me to bring these timely and general interest review papers, originally in Japanese, out in English, and under the IEEE banner. We are certain you will find this type of *translational service* beneficial, and in line with our commitment to serve the broadest possible THz community.

In addition to our focus on special issues, we plan to continue, and in fact to increase, our standards in 2015, for archival quality papers that match theory and design with experimental verification. At the same time our ongoing effort to provide an outlet for shorter manuscripts that highlight significant new ideas, timely measurements, or less complete bodies of work, continues in our *THz Letters* section. We are also considering a recent suggestion to include in each issue, a selected Review Article on a particularly prescient subject in THz science or technology. If you have suggestions, or an interest in contributing to this series, please send in your ideas for consideration (*phs@caltech.edu*).

Moving to our regular paper contributions for this month's issue—which contains some real standouts—I am sure you will find the THz vertical Schottky diode design and characterization article by *Alijabbari, Bauwens, and Weikle* at University of Virginia, Charlottesville, VA, USA, extremely interesting, especially if you read our November 2014 THz Pioneer article about Robert J. Mattauch and the diode lab at UVa. The paper from the team at Moscow State Pedagogical University, Russia (*Shurakov and Golts'man*) and Harvard Smithsonian, Boston, Massachusetts, USA *(Tong, Grimes, and Blundell*), on superconducting bolometer readouts is equally interesting, and of course relevant to our special mini-issue on the ISSTT symposium.

A paper by *Malko, Bryllert, Vukusic, and Stake* from Chalmers University, Sweden, reports the highest efficiency and output frequency, to date, for a heterojunction barrier varactor device (see our THz Pioneer article from September 2014 on Erik Kollberg). An impressive wide IF bandwidth heterodyne transceiver circuit at 300 GHz using HBT devices, is presented by *Sanggeun Jeon* and the team from Korea University in Seoul (*Kim, Yun, Yoon, Kim, and Rieh*) and Teledyne in Thousand Oaks, CA, USA (*Urteaga*). This highly integrated chipset will likely support the growing call for commercializing THz bands for close-in communications applications. To go along with

Digital Object Identifier 10.1109/TTHZ.2014.2378471

300 GHz communications systems development, we have an article from NICT (National Institute of Information and Communications Technology), Japan (*Tosaka, Fujii, Fukunaga, and Kasamatsu*) that performs and compares free space complex permittivity measurements at G-band (220–330 GHz).

Shifting to imaging, we carry a nice paper on THz holographic reconstruction of voids in lossy dielectrics from a group that includes Redstone Arsenal in Alabama, USA (*Heimbeck and Everitt*), Duke University, Durham, North Carolina, USA (*Gehm*) and University of Arizona, Tucson, Arizona, USA (*Ng and Golish*). This is followed by two metamaterials imaging applications papers. The first by a team at Ohio State University, Columbus, Ohio, USA (*Sanphuang, Yeo, Volakis, and Nahar*) who have developed a metamaterials-based sample holder that reduces multiple reflections from the holder itself. The second, from Vilnius, Lithuania (*Seliuta, Zimkaitė, Šlekas, Urbanovič, Devenson, Kancleris*), that presents a THz free space modulator composed of graphene ribbons excited by optical lasers. Finally, in a paper by *Sun, Song, and Chen* from Suzhou, China, and *Zhang* from SiChuan, China, THz free standing bandpass filters composed of subwavelength grating structures integrated on polyimide are designed and measured. High passband selectivity ($\Delta f/f < 0.002$) is achieved but with somewhat poorer transmission than obtained with free standing mesh type filters.

Our last two papers in the January issue focus on: (1) a detailed design and analysis of a pulsed THz fiber-based signal distribution system (*Bockelt, Palaci-Lopez, and Vidal-Rodriguez* from Universitat Politecnica de Valencia, Spain) and (2) an unusual focal plane array receiver configuration based on bolometers integrated with a frequency selective surface at 350 GHz for use on a balloon borne astrophysics experiment—OLIMPO (international team of *Mahashabde, Sobolev, Bengtsson, Andrén, Tarasov, Salatino, de Bernardis, Masi, and Kuzmin* from Chalmers, Sweden; Moscow, Russia; and Rome, Italy).

Although we do not have any *THz Letters* for you in this issue, our *THz Pioneer* article is on Professor Hiromasa Ito of Tohoku University and RIKEN, Sendai, Japan, who was instrumental in bringing THz crystal-based sources to light. I think you will enjoy his story.

I will close on that note, so you can get right to our first article in Volume 5, Issue 1, 2015, of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

PETER H. SIEGEL, *Editor-in-Chief*
California Institute of Technology and THz Global
Pasadena, CA 91125 USA

Peter H. Siegel (S'77–M'83–SM'98–F'01) received the B.A. degree from Colgate University, Hamilton, NY, in 1976, and the Ph.D. degree from Columbia University, New York, in 1983.

He held appointments as Faculty Associate in Electrical Engineering and Senior Scientist in Biology at Caltech, Pasadena, CA, USA, and Senior Research Scientist and Technical Group Supervisor for Submillimeter Wave Advanced Technology (SWAT) at the Jet Propulsion Laboratory (JPL) in Pasadena, CA, USA, for more than 25 years. He retired from these positions in September 2013 in order to focus on a small R&D company he started, THz Global. He is also continuing his affiliation at Caltech as a Visiting Faculty member in the Electrical Engineering Department. He has been working in the areas of millimeter and submillimeter-wave technology and applications for 40 years, and has PI'd or co-I'd more than 75 R&D programs and been involved in four major space flight instruments. He has published more than 300 articles in the THz field, and has given more than 200 invited talks in the U.S. and abroad on this subject. At JPL, he led a group of 25+ research scientists and engineers developing THz technology for NASA's near and long term space missions as well as for several Department of Defense (DoD) applications. At Caltech, he has been involved in new biological and medical applications of THz. His current interests are focused on THz applications in medicine and biology. He is extremely pleased, and very excited to be involved in the formation and launching of the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY. (His Web Pages: http://www.thz.caltech.edu; http://www.irmmw-thz.org; http://www.thz.ieee.org; http://www.thzglobal.com; e-mail: phs@caltech.edu).

Among many other duties, Dr. Siegel serves as elected General Secretary of the International Society for Infrared, Millimeter, and Terahertz Waves (IRMMW-THz), the oldest and largest venue devoted to the field of far IR techniques, science and applications, and he served as conference organizer and chair for IRMMW-THz 2008 in Pasadena and IRMMW-THz 2014 in Tucson, AZ. He also founded, incorporated and served as first President of the International Society of Infrared, Millimeter, and Terahertz Waves. He served as an IEEE Distinguished Microwave Lecturer, co-Chair and Chair of MTT Committee 4—THz Technology, a TPC and Speaker's bureau member, and as organizer and chair of seven special sessions at the IEEE International Microwave Symposia.

ADMINISTRATIVE EDITOR

Sharri Shaw was born in Michigan, and currently resides in Boulder, CO. She received the B.A. degree in English with a minor in psychology from Saginaw Valley State University in 1994. She continued her studies in 2001 in the Master in Education with Initial Certification (M.Ed.) program at Aquinas College, where she received her Secondary Level Teacher Certification.

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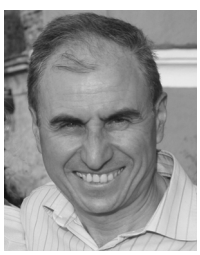
TOPIC EDITORS

René Beigang received the Diploma and Ph.D. degrees from the University of Hannover, Hannover, Germany.

He spent three years as a post-doctorate and visiting scientist at the IBM T. J. Watson Research Center, Yorktown Heights, NY. He was Associate Professor at the Free University of Berlin and the University of Kaiserslautern. He is now a full professor at the Department of Physics of the University of Kaiserslautern. Since 2005, he is also Head of the Department on Terahertz Measurement and Systems of the Fraunhofer Institute for Physical Measurement Techniques. His current research interests include nonlinear optics, generation and application of THz radiation, THz spectroscopy, applications of THz radiation in science and technology, realization and investigation of THz meta materials. (His homepage: http://www.physik.uni-kl.de/beigang).

A. Giles Davies received the B.Sc. degree in chemical physics from the University of Bristol, Bristol, U.K., in 1987, and the Ph.D. degree in semiconductor physics from the University of Cambridge, Cambridge, U.K., in 1991.

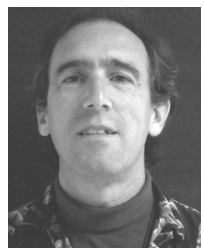
He is currently Professor of Electronic and Photonic Engineering at the University of Leeds, Leeds, U.K. His research interests concentrate on the electrical and optical properties of low-dimensional and nanostructured electronic systems, and multilayered semiconductor devices, with particular recent focus on the development of terahertz frequency systems and the exploitation of biological processes for nanoscale assembly.



Gian Piero Gallerano received the Laurea degree (Ph.D.) in physics from the University of Rome, Italy, in 1980 with a thesis on the realization of a tunable color center laser in the near infrared.

In 1981, he was a Visiting Fellow at the Technical University Hannover, Germany. In 1983 he joined the High Power Laser Laboratory at ENEA Research Center, Frascati to work on the development of infrared free electron lasers (FEL). In 1991, he was a Visiting Scholar at the Ginzton Laboratory, EE Department, Stanford University. His work on FELs lead to the realization of the ENEA Compact FEL (90–150 GHz) and of the Compact Advanced THz Source, FEL-CATS (0.4–0.7 THz). From 2001 to 2004, he has been the Coordinator of the European project THz-BRIDGE involving ten research institutes in the study the interaction of THz radiation with biological systems. From 2005 to 2007, he was in charge of the ENEA participation in the European project EUROFEL. He is currently the Head of the Radiation Sources Laboratory at ENEA Frascati. His areas of interest include generation of THz radiation and its application in the biological, biomedical, environmental and art conservation fields, THz imaging techniques, coherent emission from RF modulated electron beams, free electron lasers, optical design and diagnostics in the infrared.

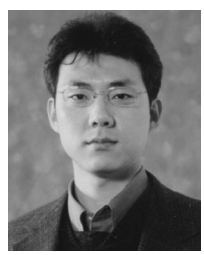
Dr. Gallerano organized the "35th International Conference on Infrared, Millimeter and THz Waves" IRMMW-THz 2010 held in Rome, Italy, September 5–10, 2010, and currently chairs the International Society of Infrared, Millimeter and Terahertz Waves, the oldest and largest forum devoted to scientific and technological developments in the wide spectral range extending from the infrared to the millimeter wave region. He has been a member of the Italian Physical Society since 1981, and is a member of the Bioelectromagnetics Society.



Erich N. Grossman received the A.B. degree in physics from Harvard College, Cambridge, MA, in 1980, and a Ph.D. degree, also in physics, from the California Institute of Technology, Pasadena, in 1987. His thesis work involved development of an ultra-low noise, heterodyne receiver for 2 THz astronomy.

From 1988 to 1989, he was a post-doctoral fellow at the University of Texas at Austin, TX, USA, and in 1989, he joined the National Institute of Standards and Technology, Boulder, CO, USA, where he is now a physicist in the Optoelectronics Division. His work at NIST focuses on infrared and submillimeter system development.

Dr. Grossman's notable accomplishments include the development and demonstration of the world's highest frequency, high efficiency lithographic antennas, the world's highest frequency Josephson junctions, (awarded a Department of Commerce Gold Medal in 1993), and early conception and development of the SQUID multiplexer, first enabling large monolithic arrays of superconducting detectors. More recently, he has developed several 0.1–1 THz cameras for security applications. He is also chair of the Metrology Working Group for the DARPA Terahertz Electronics program.



Haewook Han (M'12) received the B.S. and M.S. degrees in electrical engineering from Seoul National University, Seoul, Korea, in 1986 and 1988, respectively, and the Ph.D. degree in electrical engineering from the University of Illinois at Urbana-Champaign, Urbana, IL, USA, in 1995.

He studied low-threshold strained quantum-well heterostructure lasers and two-dimensional photonic crystal semiconductor lasers. At Bell Laboratories, Murray Hill, NJ, USA, from 1995 to 1997, he contributed to the development of 980-nm high-power semiconductor lasers. He is currently Associate Professor of the Department of Electrical and Computer Engineering at the Pohang University of Science and Technology (POSTECH). He co-founded the Korea THz Forum, and served as the Director of the Center for THz Photonics (1998–2000) and the National Laboratory for Nano-THz Photonics (2005–2009). He invented THz plastic photonic crystal fibers for single-mode THz pulse transmission in 2001. His current research interests include THz hydration dynamics of biomolecules, THz quantum interactions, and THz near-field microscopy and spectroscopy.

Peter Uhd Jepsen (M'10) received the M.Sc. degree in physics and chemistry from Odense University, Denmark, in 1994, and the Ph.D. degree in natural sciences from Århus University, Denmark in 1996.

He was at the University of Freiburg, Germany from 1996 to 2004, working with terahertz time-domain spectroscopy. From 2005, he was Associate Professor at the Technical University of Denmark (DTU), and since 2008, Professor and Head of the Terahertz Technologies and Biophotonics group at DTU. In 2008/2009, he was Visiting Professor at Osaka University. His research areas include photonics-based THz technology, broadband THz spectroscopy for chemical sensing, imaging, chemistry, and water dynamics in the THz range, and time-resolved THz spectroscopy of ultrafast phenomena in the THz range.

Kodo Kawase received the B.S. degree in electronic engineering from Kyoto University in 1989, Japan, and the Ph.D. degree in electronic engineering from Tohoku University, Japan, in 1996.

He became an Initiative Researcher at RIKEN in 2001 and a Professor in the Graduate School of Engineering, Nagoya University, Japan, in 2005. He has been conducting research activities in several directions within the THz field. Professor Kawase developed several types of widely tunable THz sources using nonlinear optical effects, and implemented them for a wide range of real-life applications. He has published more than 130 articles in the THz field and has given more than 160 invited talks on this subject.

Dr. Kawase received the 1997 Young Scientist Award from the JSAP, the 1998 Excellent Presentation Award, the 2000 and 2006 Prize of Laser Engineering from the Laser Society of Japan, the 2002 Marubun research and encouragement award and the 2006 Marubun Special Research Award from the Marubun Research Promotion Foundation (MRPF), and the 2005 Young Scientists' Prize by the Commendation for Science and Technology of the Minister of Education, Culture, Science and Technology (MEXT).

Nuria Llombart received the Electrical Engineering degree and Ph.D. degree from the Polytechnic University of Valencia, Spain, in 2002 and 2006, respectively.

During her Masters' degree studies she spent one year at the Friedrich-Alexander University of Erlangen-Nuremberg, Germany, and worked at the Fraunhofer Institute for Integrated Circuits, Erlangen, Germany. From 2002 until 2007, she was with the Antenna Group at the TNO Defence, Security and Safety Institute, The Hague, The Netherlands, working as a Ph.D. student and afterwards as a researcher. From 2007 until 2010, she was a Post-Doctoral Fellow at the California Institute of Technology, working for the Sub millimeter Wave Advance Technology group of the Jet Propulsion Laboratory (JPL), Pasadena, CA, USA. From 2010 to 2012, she held a "Ramón y Cajal" fellowship at the Optics Department of the Complutense University of Madrid, Spain. She recently relocated to Technical University of Delft, Netherlands, where she is a professor in the Electrical Engineering department, and she continues to be an affiliate at JPL, Pasadena. Her research interests include the analysis and design of planar antennas, periodic structures, reflector antennas, lens antennas, waveguide structures, with emphasis in the THz range.

Dr. Llombart was co-recipient of the H. A. Wheeler Award for the Best Applications Paper of 2008 in the IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION. She was also a co-recipient of an Honorable Mention at the 2010 European Conference of Antennas.

Victor M. Lubecke received the B.S.E.E. degree from the California State Polytechnic Institute, Pomona, CA, USA, in 1986, and the M.S. and Ph.D. degrees in electrical engineering from the California Institute of Technology, Pasadena, CA, USA, in 1990 and 1995, respectively.

He is currently a professor of Electrical Engineering at the University of Hawaii, Manoa, HI, USA. From 1998 to 2003, Dr. Lubecke was with Bell Laboratories, Lucent Technologies, where his research focused on remote sensing technologies for biomedical and industrial applications, and on microelectromechanical systems (MEMS) and 3-D wafer-scale integration technologies for wireless and optical communications. From 1987 through 1996, he was with the NASA Jet Propulsion Laboratory (JPL), and from 1996 to 1998, he was with the Institute for Physical and Chemical Research (RIKEN), Sendai, Japan, where his research involved terahertz and MEMS technologies for space remote sensing and communications applications. He holds six U.S. patents with several pending, and has published over 150 peer-reviewed research articles.

Prof. Lubecke is an emeritus Distinguished Microwave Lecturer (2006–2008) of the IEEE Microwave Theory and Techniques Society, and was a co-recipient of the Emerging Technology Award at TechConnect 2007. He co-founded and served as CTO for a start-up company that is now Kai Medical, Honolulu, HI. His current research interests include remote sensing technologies, biomedical sensors, MEMS, heterogeneous integration, and microwave/terahertz radio.

Imran Mehdi (S'83–M'90–SM'09–F'10) received the B.S.E.E. degree in 1985, the M.S.E.E. degree in 1986, and the Ph.D. degree in 1990, all from the University of Michigan.

He is currently Principal Member of Engineering staff at the Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA, and Supervisor of the JPL Submillimeter-Wave advanced Technology (SWAT) team. His responsibilities include developing THz components and subsystems for current and future NASA missions. He joined JPL in 1990 where his first task included the design and fabrication of low-parasitic planar Schottky diodes for submillimeter-wave applications. These devices were implemented on the ozone monitoring Microwave Limb Sounder instrument launched in 2004, as well as the MIRO instrument which represents the first submillimeter-wave receiver that will rendezvous with a comet in 2014. From 1999, he led the effort of developing broadband solid-state sources from 200 to 2500 GHz for the Heterodyne Instrument for Far Infrared (HIFI) on the Herschel Space Observatory, a cornerstone European Space Agency mission currently in space. This effort led to realization of wide-band solid-state sources in the THz range enabling ground-breaking astrophysics observations in space as well as at many ground-based observatories. His current interests include both mm and sub-mm wave devices, semiconductor fabrication technology, high-frequency instrumentation, and heterodyne receivers for miniature systems.

Alexander Shkurinov graduated in 1985 with honors from the Department of Physics of M.V. Lomonosov Moscow State University (MSU), and received the Ph.D. degree in physics from MSU in 1988.

In 1989, he became Research Scientist at the R.V. Khohlov Laboratory of Non-Linear Optics at MSU. His research interests are centered on the development and application of femtosecond laser techniques, time-resolved spectroscopy of molecules in the liquid phase, nonlinear optics and terahertz techniques and spectroscopy.

Dr. Shkurinov has participated in a wide range of scientific advisory boards and sat on the organizing and program committees of numerous international conferences. He was awarded the Rozhdestvensky Medal from the Russian Optical Society for his contribution into the development of optical science and technology in 2008.

Jan Stake (M'95) received the M.Sc. degree in electrical engineering and the Ph.D. degree in microwave electronics from Chalmers University of Technology, Göteborg, Sweden, in 1994 and 1999, respectively.

In 1997, he was a Research Assistant at the University of Virginia, Charlottesville, VA, USA. From 1999 to 2001, he was a Research Fellow in the millimeter wave group at the Rutherford Appleton Laboratory, U.K. He then joined Saab Combitech Systems AB as a Senior RF/microwave Engineer until 2003. From 2000 to 2006, he held different academic positions at Chalmers and was also Head of the Nanofabrication Laboratory at MC2 between 2003 and 2006. During 2007, he was a Visiting Professor in the Submillimeter Wave Advanced Technology (SWAT) group at Caltech/JPL, exploring THz applications in biology and medicine. He is currently Professor and Head of the Terahertz and Millimetre Wave Laboratory, Chalmers, Sweden. His research involves terahertz sources, detectors and mixers, high frequency semiconductor devices, graphene electronics, terahertz measurement techniques and applications.

Christopher Walker has over 25 years experience designing, building, and using state-of-the-art receiver systems for THz astronomy. He is a Professor of Astronomy and an Associate Professor of Optical Sciences and Electrical Engineering at the University of Arizona (U of A). He has worked in industry (TRW Aerospace and JPL) as well as academia. As a Millikan Fellow in Physics at Caltech, he worked on the development of low-noise, SIS waveguide receivers above 400 GHz and explored techniques for etching waveguide out of silicon. On joining the U of A faculty in 1991 he began the Steward Observatory Radio Astronomy Lab (SORAL), which has become a world leader in developing THz receiver systems for astronomy and other remote sensing applications. These instruments are multi-institutional efforts, with key components coming from JPL, several universities, and a number of industrial partners. He manages and coordinates these efforts. Instruments developed by Prof. Walker's team have served as primary facility instruments at the Heinrich Hertz Telescope on Mt. Graham, AZ, USA, and the AST/RO telescope at the South Pole. He is leading the effort to design and build the world's largest (64 pixels) submillimeter-wave heterodyne array receiver (SuperCam). He is also PI of the NASA funded long duration balloon project “The Stratospheric THz Observatory (STO)”. He has published numerous papers on star formation and protostellar evolution. He has served as dissertation director for nine Ph.D. students.

Vincent Wallace received the Ph.D. degree in medical physics from the University of London, London, U.K., in 1997.

He has nearly 20 years of experience in Biophotonics. After four years as a post doctorate at the Beckman Laser Institute and Medical Clinic, University of California, Irvine, CA, USA, he joined Toshiba Research in Cambridge, U.K., to look at potential applications of terahertz radiation. The terahertz group was spun-out of Toshiba Labs in April 2001 and became TeraView Ltd, also based in Cambridge. At TeraView, he led a group investigation the biomedical applications of terahertz technology. In 2007, he moved to the University of Western Australia to take up a full time academic role where he continues to apply terahertz and other optical techniques to biomedical and clinical problems and the understanding of the interaction of electromagnetic radiation with tissues.

Editorial

"THz" origins Contest:
Please send in your earliest reference using the term "THz" (see text below).

MARCH is upon us and we are ready to announce our winner for the 2014 *Best Paper prize*. This year the honor goes to: "**Field Exposure and Dosimetry in the THz Frequency Range**," by Thomas Kleine-Ostmann,[1] Christian Jastrow,[1] Kai Baaske,[1] Bernd Heinen,[2], Michael Schwerdtfeger,[2] Uwe Kärst,[3] Henning Hintzsche,[4] Helga Stopper,[4] Martin Koch,[2] and Thorsten Schrader,[1] published in the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY, vol. 4, no. 1, pp. 12–25, January 2014.

We had a record of 24 nominations for 2014, and I would personally like to congratulate our winners for an excellent manuscript, especially relevant to the rapidly expanding THz biomedical community. A presentation and certificates to the winners will take place at the 2015 IEEE International Microwave Symposium in Phoenix, AZ, USA between May 17–22.

In addition to our *Best Paper* prize, we have made it a tradition since 2012, to award a certificate for the *Best Reviewer* within our transactions volume year. We would like to congratulate the winner of our 2014 prize, Professor Chris Groppi at Arizona State University, Tempe, AZ, USA. Professor Groppi's record number of completed reviews (17), and his rapid average turnaround time (9.7 days) qualified him as our most outstanding reviewer for 2014.

Before we move ahead to our March issue, **I would like to ask our readers for some help with a bit of THz history**. I am seeking out the first references to the term "THz" or "terahertz" as applied to science, applications, components or measurements in the frequency range between 300 and 3000 GHz. I am especially interested in archived and retrievable journal papers or conference proceedings, as opposed to reports or presentations. I am also interested in the first appearances of the term THz, or its equivalent, in languages other than English, even if these succeed, or are derived from an English language entry. If you have one or more references to share, please send them to me at phs@caltch.edu. In return I will acknowledge both the reference and the contributor in an upcoming Editorial and in one of our upcoming THz Pioneer series introductions. *Please start scouring your files and your databases!*

This month we have a fairly full issue spanning a somewhat wider range of topics than usual. We open our March release with a tribute to THz Pioneer extraordinaire, Jun-ichi Nishizawa, whose still active career extends for more than six decades, with significant contributions in lasers and LED's, transistors and high speed tunneling devices, thyristors and power line converters, crystal growth and epitaxy techniques, and of course THz devices, instruments, applications and programs. At $88^{1}/_{2}$ years old, Nishizawa is our oldest, and one of our most venerable subjects to date. I hope you will find his story an interesting and inspiring one.

Our March technical contributions start with two linked articles on the use of THz sensing for evaluating corneal tissue water content (*Taylor et al.* at UCLA) which I am certain you will find exciting. A follow up paper from the JPL THz radar group (*Reck et al.*) with a description of an 8 pixel transceiver in the 340 GHz range is next. Our highest frequency contribution this month is a hot electron bolometer mixer in 4.7 THz waveguide (very tiny!) from groups in Cologne, Bonn and Berlin (*Büchel et al.*).

Two source papers follow, one from Korea (and Teledyne, USA) on a 300 GHz power amp with output of more than 20 mW (*Kim et al.*), and another on an amazingly high power optical-to-THz pulse power converter (3.8 mW from. 1–5 THz) from UCLA and University of Michigan (*Yardimci et al.*).

Theoretical papers from Taiwan (*Wu et al.*), China (*Du et al.*) and Korea (*Park et al.*) explore negative refraction in high-Tc superconductors, high frequency maser design, and new plasma-wave transistors respectively.

We slip in a millimeter-wave paper with potential THz applications in *Li et al.* with an unusual broadband circuit design for I-Q mixers. Next is a paper from a largely UK team (*Mueckstein et al.*) which analyzes photoexcitation at semiconductor surfaces. These are succeeded by a very neat set of linked fabrication papers from groups at Waterloo, Canada, and Giza, Egypt (*Ranjkesh et al.*), on a novel integrated circuit compatible waveguide for both MMIC's and THz applications.

The antennas group at TU Delft has contributed another very efficient on-chip antenna design that makes use of artificial dielectrics (*Syed et al.*). Lastly, we include a forward-looking paper from UC Santa Barbara (*Suen et al.*) on terahertz satellite links.

We have one quite interesting *THz Letters* article this month from groups in Poland and France (*Suszek et al.*) that describes a flat 3-D printed THz optical system for generating a line scanning beam.

I hope you will find this issue interesting and helpful, so please open Volume 5, Issue 2 of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

Digital Object Identifier 10.1109/TTHZ.2015.2401771

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[2]Philipps-Universität Marburg—Department of Physics, Marburg, Germany.

[3]Helmholtz Centre for Infection Research, Braunschweig, Germany.

[4]Institut für Pharmakologie und Toxikologie, Würzburg, Germany.

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California Institute of Technology and THz Global
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Peter H. Siegel (S'77–M'83–SM'98–F'01) received the B.A. degree from Colgate University, Hamilton, NY, in 1976, and the Ph.D. degree from Columbia University, New York, in 1983.

He held appointments as Faculty Associate in Electrical Engineering and Senior Scientist in Biology at Caltech, Pasadena, CA, USA, and Senior Research Scientist and Technical Group Supervisor for Submillimeter Wave Advanced Technology (SWAT) at the Jet Propulsion Laboratory (JPL) in Pasadena, CA, USA, for more than 25 years. He retired from these positions in September 2013 in order to focus on a small R&D company he started, THz Global. He is also continuing his affiliation at Caltech as a Visiting Faculty member in the Electrical Engineering Department. He has been working in the areas of millimeter and submillimeter-wave technology and applications for 40 years, and has PI'd or co-I'd more than 75 R&D programs and been involved in four major space flight instruments. He has published more than 300 articles in the THz field, and has given more than 200 invited talks in the U.S. and abroad on this subject. At JPL, he led a group of 25+ research scientists and engineers developing THz technology for NASA's near and long term space missions as well as for several Department of Defense (DoD) applications. At Caltech, he has been involved in new biological and medical applications of THz. His current interests are focused on THz applications in medicine and biology. He is extremely pleased, and very excited to be involved in the formation and launching of the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY. (His Web Pages: http://www.thz.caltech.edu; http://www.irmmw-thz.org; http://www.thz.ieee.org; http://www.thzglobal.com; e-mail: phs@caltech.edu).

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From 2002 to 2005, she was a teacher in Michigan. From 2006 to 2010, she was the Assistant Editor of the IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES. She currently holds the same position with *IEEE Microwave Magazine*, and also serves as the Publications Administrator for the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

TOPIC EDITORS

René Beigang received the Diploma and Ph.D. degrees from the University of Hannover, Hannover, Germany.

He spent three years as a post-doctorate and visiting scientist at the IBM T. J. Watson Research Center, Yorktown Heights, NY. He was Associate Professor at the Free University of Berlin and the University of Kaiserslautern. He is now a full professor at the Department of Physics of the University of Kaiserslautern. Since 2005, he is also Head of the Department on Terahertz Measurement and Systems of the Fraunhofer Institute for Physical Measurement Techniques. His current research interests include nonlinear optics, generation and application of THz radiation, THz spectroscopy, applications of THz radiation in science and technology, realization and investigation of THz meta materials. (His homepage: http://www.physik.uni-kl.de/beigang).

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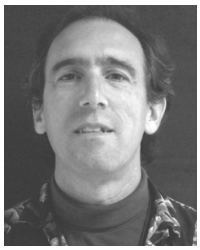

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He is currently a professor of Electrical Engineering at the University of Hawaii, Manoa, HI, USA. From 1998 to 2003, Dr. Lubecke was with Bell Laboratories, Lucent Technologies, where his research focused on remote sensing technologies for biomedical and industrial applications, and on microelectromechanical systems (MEMS) and 3-D wafer-scale integration technologies for wireless and optical communications. From 1987 through 1996, he was with the NASA Jet Propulsion Laboratory (JPL), and from 1996 to 1998, he was with the Institute for Physical and Chemical Research (RIKEN), Sendai, Japan, where his research involved terahertz and MEMS technologies for space remote sensing and communications applications. He holds six U.S. patents with several pending, and has published over 150 peer-reviewed research articles.

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Imran Mehdi (S'83–M'90–SM'09–F'10) received the B.S.E.E. degree in 1985, the M.S.E.E. degree in 1986, and the Ph.D. degree in 1990, all from the University of Michigan.

He is currently Principal Member of Engineering staff at the Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA, and Supervisor of the JPL Submillimeter-Wave advanced Technology (SWAT) team. His responsibilities include developing THz components and subsystems for current and future NASA missions. He joined JPL in 1990 where his first task included the design and fabrication of low-parasitic planar Schottky diodes for submillimeter-wave applications. These devices were implemented on the ozone monitoring Microwave Limb Sounder instrument launched in 2004, as well as the MIRO instrument which represents the first submillimeter-wave receiver that will rendezvous with a comet in 2014. From 1999, he led the effort of developing broadband solid-state sources from 200 to 2500 GHz for the Heterodyne Instrument for Far Infrared (HIFI) on the Herschel Space Observatory, a cornerstone European Space Agency mission currently in space. This effort led to realization of wide-band solid-state sources in the THz range enabling ground-breaking astrophysics observations in space as well as at many ground-based observatories. His current interests include both mm and sub-mm wave devices, semiconductor fabrication technology, high-frequency instrumentation, and heterodyne receivers for miniature systems.

Alexander Shkurinov graduated in 1985 with honors from the Department of Physics of M.V. Lomonosov Moscow State University (MSU), and received the Ph.D. degree in physics from MSU in 1988.

In 1989, he became Research Scientist at the R.V. Khohlov Laboratory of Non-Linear Optics at MSU. His research interests are centered on the development and application of femtosecond laser techniques, time-resolved spectroscopy of molecules in the liquid phase, nonlinear optics and terahertz techniques and spectroscopy.

Dr. Shkurinov has participated in a wide range of scientific advisory boards and sat on the organizing and program committees of numerous international conferences. He was awarded the Rozhdestvensky Medal from the Russian Optical Society for his contribution into the development of optical science and technology in 2008.

Jan Stake (M'95) received the M.Sc. degree in electrical engineering and the Ph.D. degree in microwave electronics from Chalmers University of Technology, Göteborg, Sweden, in 1994 and 1999, respectively.

In 1997, he was a Research Assistant at the University of Virginia, Charlottesville, VA, USA. From 1999 to 2001, he was a Research Fellow in the millimeter wave group at the Rutherford Appleton Laboratory, U.K. He then joined Saab Combitech Systems AB as a Senior RF/microwave Engineer until 2003. From 2000 to 2006, he held different academic positions at Chalmers and was also Head of the Nanofabrication Laboratory at MC2 between 2003 and 2006. During 2007, he was a Visiting Professor in the Submillimeter Wave Advanced Technology (SWAT) group at Caltech/JPL, exploring THz applications in biology and medicine. He is currently Professor and Head of the Terahertz and Millimetre Wave Laboratory, Chalmers, Sweden. His research involves terahertz sources, detectors and mixers, high frequency semiconductor devices, graphene electronics, terahertz measurement techniques and applications.

Christopher Walker has over 25 years experience designing, building, and using state-of-the-art receiver systems for THz astronomy. He is a Professor of Astronomy and an Associate Professor of Optical Sciences and Electrical Engineering at the University of Arizona (U of A). He has worked in industry (TRW Aerospace and JPL) as well as academia. As a Millikan Fellow in Physics at Caltech, he worked on the development of low-noise, SIS waveguide receivers above 400 GHz and explored techniques for etching waveguide out of silicon. On joining the U of A faculty in 1991 he began the Steward Observatory Radio Astronomy Lab (SORAL), which has become a world leader in developing THz receiver systems for astronomy and other remote sensing applications. These instruments are multi-institutional efforts, with key components coming from JPL, several universities, and a number of industrial partners. He manages and coordinates these efforts. Instruments developed by Prof. Walker's team have served as primary facility instruments at the Heinrich Hertz Telescope on Mt. Graham, AZ, USA, and the AST/RO telescope at the South Pole. He is leading the effort to design and build the world's largest (64 pixels) submillimeter-wave heterodyne array receiver (SuperCam). He is also PI of the NASA funded long duration balloon project "The Stratospheric THz Observatory (STO)". He has published numerous papers on star formation and protostellar evolution. He has served as dissertation director for nine Ph.D. students.

Vincent Wallace received the Ph.D. degree in medical physics from the University of London, London, U.K., in 1997.

He has nearly 20 years of experience in Biophotonics. After four years as a post doctorate at the Beckman Laser Institute and Medical Clinic, University of California, Irvine, CA, USA, he joined Toshiba Research in Cambridge, U.K., to look at potential applications of terahertz radiation. The terahertz group was spun-out of Toshiba Labs in April 2001 and became TeraView Ltd, also based in Cambridge. At TeraView, he led a group investigation the biomedical applications of terahertz technology. In 2007, he moved to the University of Western Australia to take up a full time academic role where he continues to apply terahertz and other optical techniques to biomedical and clinical problems and the understanding of the interaction of electromagnetic radiation with tissues.

Editorial

"THz" Origins Contest
Please send in your earliest reference using the term "THz" (*see the penultimate paragraph below*).

OUR May 2015 issue contains our promised *Special Issue on Terahertz Nanomaterials and Applications*, as advertised in our **Call for Papers** last March, as well as a good number of regular manuscript contributions.

Special Issue Guest Editors: Dr. Goutam Chattopadhyay, Dr. Fabio Coccetti, Dr. Luca Pierantoni, Dr. Thomas Mitchell Wallis, and our own Dr. Imran Mehdi, have been working very hard to meet our May issue contribution deadline. They have collected a dozen topical papers covering this cross-disciplinary field, which is drawing in more and more THz researchers. After looking through these contributions, I am certain you will appreciate both the parallels, and the overlap between nanostructures and THz. You can find a nice introduction to the Special Issue papers following our *THz Pioneer* article, so I will not mention these contributions individually here.

In our regular manuscript submissions this month we include 11 full length papers and one *THz Letter*. Despite a survey more than a year ago, in which many authors specifically requested a forum for shorter manuscripts in our journal, we are not receiving large numbers of *THz Letters* contributions. Our overall statistics since the start of the journal, on the time period from submission-to-decision, averages out at 7 weeks, so I encourage those of you who are reluctant to submit your shorter manuscripts for fear of losing out on publication priority, to reconsider.

This month our regular paper contributions cover a wide range of topics including two papers on imaging, two papers on superconducting devices, continuous wave THz generation in an optical fiber, a rare paper on a high power THz source generated by relativistic electron beams, a rigorous analysis of 2D plasmonic devices, slotted and slanted THz gratings, and two papers on THz output from BSCCO high temperature superconducting Josephson junction oscillators. Our single *THz Letter* contribution resurrects the Schottky diode harmonic mixer, with results on a 4th-harmonic design at 440 GHz.

Our THz Pioneer article this month is on U.K. physicist, Professor Derek H. Martin, who is best known for his widely used spectral filtering technique—the Martin–Pupplett interferometer—as well as his early work on quasi-optics and wide-band feed horns. As one of our most senior interviewees, Professor Martin's contributions may predate most reader's birthdates, so please take a few moments to glance over his history. I am certain you will find some interesting tidbits to digest and ponder!

Before ending, **I would like to again ask our readers for some help with a bit of THz history**. I am still seeking out the first references to the term "THz" or "terahertz" as applied to science, applications, components or measurements in the frequency range between 300 and 3000 GHz. I am especially interested in archived and retrievable journal papers or conference proceedings, as opposed to reports or presentations. I am also interested in the first appearances of the term ***THz***, or its equivalent, in languages other than English, even if these succeed, or are derived from an English language entry. If you have one or more references to share, please send them to me at phs@caltech.edu. In return I will acknowledge both the reference and the contributor in an upcoming Editorial and in one of our upcoming THz Pioneer series introductions. *Please start scouring your files and your databases!*

As usual I would like to thank our reviewers, our authors, our Topic Editors, and our administrative editors for the continuous contributions and professionalism that are necessary precursors for making this journal a success. Please honor their commitment by opening to Volume 5, Issue 3 of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

PETER H. SIEGEL, *Editor-in-Chief*
California Institute of Technology and THz Global
Pasadena, CA 91125 USA

Peter H. Siegel (S'77–M'83–SM'98–F'01) received the B.A. degree from Colgate University, Hamilton, NY, in 1976, and the Ph.D. degree from Columbia University, New York, in 1983.

He held appointments as Faculty Associate in Electrical Engineering and Senior Scientist in Biology at Caltech, Pasadena, CA, USA, and Senior Research Scientist and Technical Group Supervisor for Submillimeter Wave Advanced Technology (SWAT) at the Jet Propulsion Laboratory (JPL) in Pasadena, CA, USA, for more than 25 years. He retired from these positions in September 2013 in order to focus on a small R&D company he started, THz Global. He is also continuing his affiliation at Caltech as a Visiting Faculty member in the Electrical Engineering Department. He has been working in the areas of millimeter and submillimeter-wave technology and applications for 40 years, and has PI'd or co-I'd more than 75 R&D programs and been involved in four major space flight instruments. He has published more than 300 articles in the THz field, and has given more than 200 invited talks in the U.S. and abroad on this subject. At JPL, he led a group of 25+ research scientists and engineers developing THz technology for NASA's near and long term space missions as well as for several Department of Defense (DoD) applications. At Caltech, he has been involved in new biological and medical applications of THz. His current interests are focused on THz applications in medicine and biology. He is extremely pleased, and very excited to be involved in the formation and launching of the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY. (His Web Pages: http://www.thz.caltech.edu; http://www.irmmw-thz.org; http://www.thz.ieee.org; http://www.thzglobal.com; e-mail: phs@caltech.edu).

Digital Object Identifier 10.1109/TTHZ.2015.2419176

Among many other duties, Dr. Siegel serves as elected General Secretary of the International Society for Infrared, Millimeter, and Terahertz Waves (IRMMW-THz), the oldest and largest venue devoted to the field of far IR techniques, science and applications, and he served as conference organizer and chair for IRMMW-THz 2008 in Pasadena and IRMMW-THz 2014 in Tucson, AZ. He also founded, incorporated and served as first President of the International Society of Infrared, Millimeter, and Terahertz Waves. He served as an IEEE Distinguished Microwave Lecturer, co-Chair and Chair of MTT Committee 4—THz Technology, a TPC and Speaker's bureau member, and as organizer and chair of seven special sessions at the IEEE International Microwave Symposia.

ADMINISTRATIVE EDITOR

Sharri Shaw was born in Michigan, and currently resides in Boulder, CO. She received the B.A. degree in English with a minor in psychology from Saginaw Valley State University in 1994. She continued her studies in 2001 in the Master in Education with Initial Certification (M.Ed.) program at Aquinas College, where she received her Secondary Level Teacher Certification.

From 2002 to 2005, she was a teacher in Michigan. From 2006 to 2010, she was the Assistant Editor of the IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES. She currently holds the same position with *IEEE Microwave Magazine*, and also serves as the Publications Administrator for the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

TOPIC EDITORS

René Beigang received the Diploma and Ph.D. degrees from the University of Hannover, Hannover, Germany.

He spent three years as a post-doctorate and visiting scientist at the IBM T. J. Watson Research Center, Yorktown Heights, NY. He was Associate Professor at the Free University of Berlin and the University of Kaiserslautern. He is now a full professor at the Department of Physics of the University of Kaiserslautern. Since 2005, he is also Head of the Department on Terahertz Measurement and Systems of the Fraunhofer Institute for Physical Measurement Techniques. His current research interests include nonlinear optics, generation and application of THz radiation, THz spectroscopy, applications of THz radiation in science and technology, realization and investigation of THz meta materials. (His homepage: http://www.physik.uni-kl.de/beigang).

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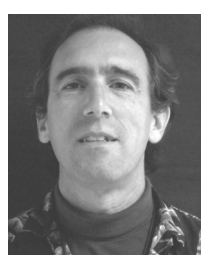

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Prof. Lubecke is an emeritus Distinguished Microwave Lecturer (2006–2008) of the IEEE Microwave Theory and Techniques Society, and was a co-recipient of the Emerging Technology Award at TechConnect 2007. He co-founded and served as CTO for a start-up company that is now Kai Medical, Honolulu, HI. His current research interests include remote sensing technologies, biomedical sensors, MEMS, heterogeneous integration, and microwave/terahertz radio.

Imran Mehdi (S'83–M'90–SM'09–F'10) received the B.S.E.E. degree in 1985, the M.S.E.E. degree in 1986, and the Ph.D. degree in 1990, all from the University of Michigan.

He is currently Principal Member of Engineering staff at the Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA, and Supervisor of the JPL Submillimeter-Wave advanced Technology (SWAT) team. His responsibilities include developing THz components and subsystems for current and future NASA missions. He joined JPL in 1990 where his first task included the design and fabrication of low-parasitic planar Schottky diodes for submillimeter-wave applications. These devices were implemented on the ozone monitoring Microwave Limb Sounder instrument launched in 2004, as well as the MIRO instrument which represents the first submillimeter-wave receiver that will rendezvous with a comet in 2014. From 1999, he led the effort of developing broadband solid-state sources from 200 to 2500 GHz for the Heterodyne Instrument for Far Infrared (HIFI) on the Herschel Space Observatory, a cornerstone European Space Agency mission currently in space. This effort led to realization of wide-band solid-state sources in the THz range enabling ground-breaking astrophysics observations in space as well as at many ground-based observatories. His current interests include both mm and sub-mm wave devices, semiconductor fabrication technology, high-frequency instrumentation, and heterodyne receivers for miniature systems.

Alexander Shkurinov graduated in 1985 with honors from the Department of Physics of M.V. Lomonosov Moscow State University (MSU), and received the Ph.D. degree in physics from MSU in 1988.

In 1989, he became Research Scientist at the R.V. Khohlov Laboratory of Non-Linear Optics at MSU. His research interests are centered on the development and application of femtosecond laser techniques, time-resolved spectroscopy of molecules in the liquid phase, nonlinear optics and terahertz techniques and spectroscopy.

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Jan Stake (M'95) received the M.Sc. degree in electrical engineering and the Ph.D. degree in microwave electronics from Chalmers University of Technology, Göteborg, Sweden, in 1994 and 1999, respectively.

In 1997, he was a Research Assistant at the University of Virginia, Charlottesville, VA, USA. From 1999 to 2001, he was a Research Fellow in the millimeter wave group at the Rutherford Appleton Laboratory, U.K. He then joined Saab Combitech Systems AB as a Senior RF/microwave Engineer until 2003. From 2000 to 2006, he held different academic positions at Chalmers and was also Head of the Nanofabrication Laboratory at MC2 between 2003 and 2006. During 2007, he was a Visiting Professor in the Submillimeter Wave Advanced Technology (SWAT) group at Caltech/JPL, exploring THz applications in biology and medicine. He is currently Professor and Head of the Terahertz and Millimetre Wave Laboratory, Chalmers, Sweden. His research involves terahertz sources, detectors and mixers, high frequency semiconductor devices, graphene electronics, terahertz measurement techniques and applications.

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Editorial

"THz" Origins Contest

Please send in your earliest reference using the term "THz" in any language! We are searching for the first occurrences for the use of this terminology to describe electromagnetic waves in the science literature.

Email your entries to Peter Siegel at: phs@caltech.edu

JULY 2015 contains our summer print grouping, which includes the first part of a Special Mini-Issue highlighting THz research from two mainly Russian organized conferences—the *16th International Conference on Laser Optics*, held in St. Petersburg, Russia, from June 30–July 4, 2014, and the *International Conference on Advanced Laser Technologies (ALT 2014)*, held in Cassis, France, from October 6–10, 2014.

Topic Editor, Professor Alexander Shkurinov (Moscow State University), and Guest Editor, Professor Jean-Louis Coutaz (University of Savoy), have assembled the papers for this Special Mini-Issue, which will be included in both this, and the September print issues of our Transactions. One of the goals of this Special Mini-Issue is to highlight some research by authors in Russia that might not otherwise appear in English language journals. This month, we include 5 expanded papers from the two conferences, and in September we plan to have another 5 or so manuscripts to accompany our regular print release.

Our regular July issue paper contributions include a dozen original unsolicited manuscripts on topics ranging from 4.7 THz heterodyne receiver local oscillator sources to THz carrier dynamics in silicon nanowires. There are also articles on tunable filters, THz optical and quasi-optical systems, spoof plasmon-based devices, optical delay lines, THz FET transistors, THz resonant tunneling diode oscillators, and millimeter wave spectrometers and wireless transmission systems. We include two papers that did not make it into our January ISSTT and our May Nanomaterials special mini-issues, which we felt deserved attention. We also have three *THz Letters* this month and a lengthy *Corrections* to an earlier contribution. The *THz Pioneer* article for July covers the career of noted radio astronomer and quasi-optics specialist, Dr. Paul Goldsmith, who has served as a bridge between the THz technology and science communities, as well as between a broad swath of the radio spectrum—from MHz to THz.

I have so far received one response to our *THz Origins* contest, from Tohoku University's, Professor Koji Mizuno[1] who attributes the first use of the term "THz" in Japan to a Japanese Science and Technology (JST) office program, ERATO, started in 1987 by Professor Jun-ichi Nishizawa[2] and titled "The Nishizawa Terahertz Project." I would like to encourage others to send me similar references to the term "THz" either in English or in their own native language. If possible I would like to pin down the very first use of this term (over submillimeter or mega-megahertz for example) and try to follow how and when the term came into popular use. Please send your references to me, Peter Siegel, at phs@caltech.edu, and I will continue to post new entries as they come in.

In September/November, we are planning to have a very exciting Special Mini-Issue on THz Applications, that comes to us in the form of original author translations from articles in Japanese that appeared in a November 2014 IEICE of Japan special THz volume. I am certain you will find many articles in this upcoming issue of great interest. We also plan to include a large number of regular paper contributions and the second part of our mini-special issue highlighting expanded papers from the two Russian organized conferences that appear in our July release.

In conclusion, I want to thank our reviewers, our authors, our Topic Editors, and our administrative editors for their continuing contributions to our journal and for their support of the THz community as a whole. Please do them justice by reading Volume 5, Issue 4 of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

PETER H. SIEGEL, *Editor-in-Chief*
California Institute of Technology and
THz Global
Pasadena, CA 91125 USA

Peter H. Siegel (S'77–M'83–SM'98–F'01) received the B.A. degree from Colgate University, Hamilton, NY, in 1976, and the Ph.D. degree from Columbia University, New York, in 1983.

He held appointments as Faculty Associate in Electrical Engineering and Senior Scientist in Biology at Caltech, Pasadena, CA, USA, and Senior Research Scientist and Technical Group Supervisor for Submillimeter Wave Advanced Technology (SWAT) at the Jet Propulsion Laboratory (JPL) in Pasadena, CA, USA, for more than 25 years. He retired from these positions in September 2013 in order to focus on a small R&D company he started, THz Global. He is also continuing his affiliation at Caltech as a Visiting Faculty member in the Electrical Engineering Department. He has been working in the areas of millimeter and submillimeter-wave technology and applications for 40 years, and has PI'd or co-I'd more than 75 R&D programs and been involved in four major space flight instruments. He has published more than 300 articles in the THz field, and has given more than 200 invited talks in the U.S. and abroad on this subject. At JPL, he led a group of 25+ research scientists and engineers developing THz technology

Digital Object Identifier 10.1109/TTHZ.2015.2443675

[1]See: Peter H. Siegel, "THz Pioneer: Koji Mizuno—50 Years in Submillimeter-Waves: From Osaku to Sensei," *IEEE Trans. THz Sci. Technol.*, vol. 3, no. 2, pp. 129–133, Mar. 2013.

[2]See: Peter H. Siegel, "THz Pioneer Jun-ichi Nishizawa, THz Shogun," *IEEE Trans. THz Sci. Technol.*, vol. 5, no. 2, pp. 161–169, Mar. 2015.

for NASA's near and long term space missions as well as for several Department of Defense (DoD) applications. At Caltech, he has been involved in new biological and medical applications of THz. His current interests are focused on THz applications in medicine and biology. He is extremely pleased, and very excited to be involved in the formation and launching of the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY. (His Web Pages: http://www.thz.caltech.edu; http://www.irmmw-thz.org; http://www.thz.ieee.org; http://www.thzglobal.com; e-mail: phs@caltech.edu).

Among many other duties, Dr. Siegel serves as elected General Secretary of the International Society for Infrared, Millimeter, and Terahertz Waves (IRMMW-THz), the oldest and largest venue devoted to the field of far IR techniques, science and applications, and he served as conference organizer and chair for IRMMW-THz 2008 in Pasadena and IRMMW-THz 2014 in Tucson, AZ. He also founded, incorporated and served as first President of the International Society of Infrared, Millimeter, and Terahertz Waves. He served as an IEEE Distinguished Microwave Lecturer, co-Chair and Chair of MTT Committee 4—THz Technology, a TPC and Speaker's bureau member, and as organizer and chair of seven special sessions at the IEEE International Microwave Symposia.

ADMINISTRATIVE EDITOR

Sharri Shaw was born in Michigan, and currently resides in Boulder, CO. She received the B.A. degree in English with a minor in psychology from Saginaw Valley State University in 1994. She continued her studies in 2001 in the Master in Education with Initial Certification (M.Ed.) program at Aquinas College, where she received her Secondary Level Teacher Certification.

From 2002 to 2005, she was a teacher in Michigan. From 2006 to 2010, she was the Assistant Editor of the IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES. She currently holds the same position with *IEEE Microwave Magazine*, and also serves as the Publications Administrator for the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

TOPIC EDITORS

René Beigang received the Diploma and Ph.D. degrees from the University of Hannover, Hannover, Germany.

He spent three years as a post-doctorate and visiting scientist at the IBM T. J. Watson Research Center, Yorktown Heights, NY. He was Associate Professor at the Free University of Berlin and the University of Kaiserslautern. He is now a full professor at the Department of Physics of the University of Kaiserslautern. Since 2005, he is also Head of the Department on Terahertz Measurement and Systems of the Fraunhofer Institute for Physical Measurement Techniques. His current research interests include nonlinear optics, generation and application of THz radiation, THz spectroscopy, applications of THz radiation in science and technology, realization and investigation of THz meta materials. (His homepage: http://www.physik.uni-kl.de/beigang).

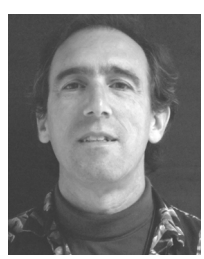
A. Giles Davies received the B.Sc. degree in chemical physics from the University of Bristol, Bristol, U.K., in 1987, and the Ph.D. degree in semiconductor physics from the University of Cambridge, Cambridge, U.K., in 1991.

He is currently Professor of Electronic and Photonic Engineering at the University of Leeds, Leeds, U.K. His research interests concentrate on the electrical and optical properties of low-dimensional and nanostructured electronic systems, and multilayered semiconductor devices, with particular recent focus on the development of terahertz frequency systems and the exploitation of biological processes for nanoscale assembly.

Gian Piero Gallerano received the Laurea degree (Ph.D.) in physics from the University of Rome, Italy, in 1980 with a thesis on the realization of a tunable color center laser in the near infrared.

In 1981, he was a Visiting Fellow at the Technical University Hannover, Germany. In 1983 he joined the High Power Laser Laboratory at ENEA Research Center, Frascati to work on the development of infrared free electron lasers (FEL). In 1991, he was a Visiting Scholar at the Ginzton Laboratory, EE Department, Stanford University. His work on FELs lead to the realization of the ENEA Compact FEL (90–150 GHz) and of the Compact Advanced THz Source, FEL-CATS (0.4–0.7 THz). From 2001 to 2004, he has been the Coordinator of the European project THz-BRIDGE involving ten research institutes in the study the interaction of THz radiation with biological systems. From 2005 to 2007, he was in charge of the ENEA participation in the European project EUROFEL. He is currently the Head of the Radiation Sources Laboratory at ENEA Frascati. His areas of interest include generation of THz radiation and its application in the biological, biomedical, environmental and art conservation fields, THz imaging techniques, coherent emission from RF modulated electron beams, free electron lasers, optical design and diagnostics in the infrared.

Dr. Gallerano organized the "35th International Conference on Infrared, Millimeter and THz Waves" IRMMW-THz 2010 held in Rome, Italy, September 5–10, 2010, and currently chairs the International Society of Infrared, Millimeter and Terahertz Waves, the oldest and largest forum devoted to scientific and technological developments in the wide spectral range extending from the infrared to the millimeter wave region. He has been a member of the Italian Physical Society since 1981, and is a member of the Bioelectromagnetics Society.



Erich N. Grossman received the A.B. degree in physics from Harvard College, Cambridge, MA, in 1980, and a Ph.D. degree, also in physics, from the California Institute of Technology, Pasadena, in 1987. His thesis work involved development of an ultra-low noise, heterodyne receiver for 2 THz astronomy.

From 1988 to 1989, he was a post-doctoral fellow at the University of Texas at Austin, TX, USA, and in 1989, he joined the National Institute of Standards and Technology, Boulder, CO, USA, where he is now a physicist in the Optoelectronics Division. His work at NIST focuses on infrared and submillimeter system development.

Dr. Grossman's notable accomplishments include the development and demonstration of the world's highest frequency, high efficiency lithographic antennas, the world's highest frequency Josephson junctions, (awarded a Department of Commerce Gold Medal in 1993), and early conception and development of the SQUID multiplexer, first enabling large monolithic arrays of superconducting detectors. More recently, he has developed several 0.1–1 THz cameras for security applications. He is also chair of the Metrology Working Group for the DARPA Terahertz Electronics program.

Haewook Han (M'12) received the B.S. and M.S. degrees in electrical engineering from Seoul National University, Seoul, Korea, in 1986 and 1988, respectively, and the Ph.D. degree in electrical engineering from the University of Illinois at Urbana-Champaign, Urbana, IL, USA, in 1995.

He studied low-threshold strained quantum-well heterostructure lasers and two-dimensional photonic crystal semiconductor lasers. At Bell Laboratories, Murray Hill, NJ, USA, from 1995 to 1997, he contributed to the development of 980-nm high-power semiconductor lasers. He is currently Associate Professor of the Department of Electrical and Computer Engineering at the Pohang University of Science and Technology (POSTECH). He co-founded the Korea THz Forum, and served as the Director of the Center for THz Photonics (1998–2000) and the National Laboratory for Nano-THz Photonics (2005–2009). He invented THz plastic photonic crystal fibers for single-mode THz pulse transmission in 2001. His current research interests include THz hydration dynamics of biomolecules, THz quantum interactions, and THz near-field microscopy and spectroscopy.

Peter Uhd Jepsen (M'10) received the M.Sc. degree in physics and chemistry from Odense University, Denmark, in 1994, and the Ph.D. degree in natural sciences from Århus University, Denmark in 1996.

He was at the University of Freiburg, Germany from 1996 to 2004, working with terahertz time-domain spectroscopy. From 2005, he was Associate Professor at the Technical University of Denmark (DTU), and since 2008, Professor and Head of the Terahertz Technologies and Biophotonics group at DTU. In 2008/2009, he was Visiting Professor at Osaka University. His research areas include photonics-based THz technology, broadband THz spectroscopy for chemical sensing, imaging, chemistry, and water dynamics in the THz range, and time-resolved THz spectroscopy of ultrafast phenomena in the THz range.

Kodo Kawase received the B.S. degree in electronic engineering from Kyoto University in 1989, Japan, and the Ph.D. degree in electronic engineering from Tohoku University, Japan, in 1996.

He became an Initiative Researcher at RIKEN in 2001 and a Professor in the Graduate School of Engineering, Nagoya University, Japan, in 2005. He has been conducting research activities in several directions within the THz field. Professor Kawase developed several types of widely tunable THz sources using nonlinear optical effects, and implemented them for a wide range of real-life applications. He has published more than 130 articles in the THz field and has given more than 160 invited talks on this subject.

Dr. Kawase received the 1997 Young Scientist Award from the JSAP, the 1998 Excellent Presentation Award, the 2000 and 2006 Prize of Laser Engineering from the Laser Society of Japan, the 2002 Marubun research and encouragement award and the 2006 Marubun Special Research Award from the Marubun Research Promotion Foundation (MRPF), and the 2005 Young Scientists' Prize by the Commendation for Science and Technology of the Minister of Education, Culture, Science and Technology (MEXT).

Nuria Llombart received the Electrical Engineering degree and Ph.D. degree from the Polytechnic University of Valencia, Spain, in 2002 and 2006, respectively.

During her Masters' degree studies she spent one year at the Friedrich-Alexander University of Erlangen-Nuremberg, Germany, and worked at the Fraunhofer Institute for Integrated Circuits, Erlangen, Germany. From 2002 until 2007, she was with the Antenna Group at the TNO Defence, Security and Safety Institute, The Hague, The Netherlands, working as a Ph.D. student and afterwards as a researcher. From 2007 until 2010, she was a Post-Doctoral Fellow at the California Institute of Technology, working for the Sub millimeter Wave Advance Technology group of the Jet Propulsion Laboratory (JPL), Pasadena, CA, USA. From 2010 to 2012, she held a "Ramón y Cajal" fellowship at the Optics Department of the Complutense University of Madrid, Spain. She recently relocated to Technical University of Delft, Netherlands, where she is a professor in the Electrical Engineering department, and she continues to be an affiliate at JPL, Pasadena. Her research interests include the analysis and design of planar antennas, periodic structures, reflector antennas, lens antennas, waveguide structures, with emphasis in the THz range.

Dr. Llombart was co-recipient of the H. A. Wheeler Award for the Best Applications Paper of 2008 in the IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION. She was also a co-recipient of an Honorable Mention at the 2010 European Conference of Antennas.

Victor M. Lubecke received the B.S.E.E. degree from the California State Polytechnic Institute, Pomona, CA, USA, in 1986, and the M.S. and Ph.D. degrees in electrical engineering from the California Institute of Technology, Pasadena, CA, USA, in 1990 and 1995, respectively.

He is currently a professor of Electrical Engineering at the University of Hawaii, Manoa, HI, USA. From 1998 to 2003, Dr. Lubecke was with Bell Laboratories, Lucent Technologies, where his research focused on remote sensing technologies for biomedical and industrial applications, and on microelectromechanical systems (MEMS) and 3-D wafer-scale integration technologies for wireless and optical communications. From 1987 through 1996, he was with the NASA Jet Propulsion Laboratory (JPL), and from 1996 to 1998, he was with the Institute for Physical and Chemical Research (RIKEN), Sendai, Japan, where his research involved terahertz and MEMS technologies for space remote sensing and communications applications. He holds six U.S. patents with several pending, and has published over 150 peer-reviewed research articles.

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AT THIS START of our fifth print year, I am reminded of our Inaugural Issue of September 2011 when the acceptance of this new journal was wholly in question. Since that time I have been overwhelmed and overjoyed by the response of the THz community. With your help, we have become a mainstream IEEE publication with a strong following and a bright future. I cannot be more pleased and more proud of the people who have made this happen. Again I would like to acknowledge and thank the former Presidents of the IEEE Microwave Theory and Techniques Society for their unwavering support of this publication: Samir El-Ghazaly, Richard Snyder, Nick Kolias, Madhu Gupta, Robert Weigel, and now Tim Lee. All of us in the THz community are grateful for your efforts behind the scenes.

Although we had intended to bring you a special issue this month focusing on THz Applications from an IEICE publication in Japanese that appeared last November, we have had to postpone this print release until the November issue. Instead, we bring you 10 regular manuscript submissions and Part II of our Special Mini Issue highlighting expanded papers from two Russian organized conferences with THz focus—the *16th International Conference on Laser Optics*, held in St. Petersburg, Russia from June 30-July 4, 2014, and the *International Conference on Advanced Laser Technologies* (ALT 2014), held in Cassis, France from October 6–10, 2014.

As with our July print issue, Topic Editor, Professor Alexander Shkurinov (Moscow State University), and Guest Editor, Professor Jean-Louis Coutaz (University of Savoie), have assembled the papers for the special mini-issue, with the goal of highlighting research by authors in Russia that might not otherwise appear in English language journals. The final portion of this special mini-issue includes 7 papers with an Introduction by the two Special Issue Guest Editors.

We start off our September 2015 issue with a rule-bending Terahertz Pioneer article on Professor Xi-Cheng Zhang, which I have subtitled, *The Face of THz*. It is not an exaggeration to say that Professor Zhang is recognizable to almost every THz researcher around the globe. His unique background only adds to his mystique, and so I have taken the liberty of deviating from my requirement that Pioneer candidates be 65 or older this one time. I do not think anyone will object in this very special case of a person who has given so much, to so many, in our niche community.

Our first regular manuscript contribution, from *Jingyue Jia et al.*, is a theoretical paper describing an optimized high temperature regime (70–100 K) photon-noise limited quantum well detector for the mid to high THz frequency regime.

Our second paper is also a theoretical design paper by *Mohammad Yarahmadi et al.* from Tehran, which describes switches and full THz logic gates based on graphene.

After this, *Michael Bakunov et al.* bring us a paper on significantly improved efficiency in electro-optic sampling in GaAs.

We get another look at communications applications and circuitry in the millimeter-wave regime from *Shahab Ardalan et al.* at San Jose State University. This paper implements a full OOK chip-to-chip transceiver with more than 10 Gbit/s data rate at 210 GHz.

From *Grishkowsky's* group at Oklahoma State, *Moon et al.* submit a practical paper on long distance (186 m) THz pulse propagation measurements under different weather conditions – including rain and snow.

Our sixth paper, by *Zhu et al.* present new THz fiber designs for broad band single mode operation.

From *Derek Abbott's* team at University of Adelaide, *Ebrahami et al.* introduce a new microfabricated frequency selective surface composed of sandwiched metallic and dielectric layers. They include a full analysis with measured performance as well as design information.

Vessen Vassilev et al. contribute a paper on *measuring paper*! That is, highly accurate remote determination of moisture content in layers of thin paper using millimeter-wave transceivers intended for industrial use.

Our final contribution for September is a paper from *EunMi Choi et al.* describing a new technique to measure ultra-high power millimeter and submillimeter-wave sources based on highly accurate antenna transmit/receive characteristics.

Following our regular papers we have 7 final Special Mini-Issue articles that are introduced by *Jean Louis Coutaz and Alexander Shkurinov*. These contributions close off our Russian conference focused papers.

Before concluding, I would like to again remind readers to send me early references to the term "THz" either in English or in their own native language as part of our THz Origins contest.

Now turn the page to start Volume 5, Issue 5 of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

PETER H. SIEGEL, *Editor-in-Chief*
California Institute of Technology and
THz Global
Pasadena, CA 91125 USA

Digital Object Identifier 10.1109/TTHZ.2015.2465791

Peter H. Siegel (S'77–M'83–SM'98–F'01) received the B.A. degree from Colgate University, Hamilton, NY, in 1976, and the Ph.D. degree from Columbia University, New York, in 1983.

He held appointments as Faculty Associate in Electrical Engineering and Senior Scientist in Biology at Caltech, Pasadena, CA, USA, and Senior Research Scientist and Technical Group Supervisor for Submillimeter Wave Advanced Technology (SWAT) at the Jet Propulsion Laboratory (JPL) in Pasadena, CA, USA, for more than 25 years. He retired from these positions in September 2013 in order to focus on a small R&D company he started, THz Global. He is also continuing his affiliation at Caltech as a Visiting Faculty member in the Electrical Engineering Department. He has been working in the areas of millimeter and submillimeter-wave technology and applications for 40 years, and has PI'd or co-I'd more than 75 R&D programs and been involved in four major space flight instruments. He has published more than 300 articles in the THz field, and has given more than 200 invited talks in the U.S. and abroad on this subject. At JPL, he led a group of 25+ research scientists and engineers developing THz technology for NASA's near and long term space missions as well as for several Department of Defense (DoD) applications. At Caltech, he has been involved in new biological and medical applications of THz. His current interests are focused on THz applications in medicine and biology. He is extremely pleased, and very excited to be involved in the formation and launching of the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY. (His Web Pages: http://www.thz.caltech.edu; http://www.irmmw-thz.org; http://www.thz.ieee.org; http://www.thzglobal.com; e-mail: phs@caltech.edu).

Among many other duties, Dr. Siegel serves as elected General Secretary of the International Society for Infrared, Millimeter, and Terahertz Waves (IRMMW-THz), the oldest and largest venue devoted to the field of far IR techniques, science and applications, and he served as conference organizer and chair for IRMMW-THz 2008 in Pasadena and IRMMW-THz 2014 in Tucson, AZ. He also founded, incorporated and served as first President of the International Society of Infrared, Millimeter, and Terahertz Waves. He served as an IEEE Distinguished Microwave Lecturer, co-Chair and Chair of MTT Committee 4—THz Technology, a TPC and Speaker's bureau member, and as organizer and chair of seven special sessions at the IEEE International Microwave Symposia.

ADMINISTRATIVE EDITOR

Sharri Shaw was born in Michigan, and currently resides in Boulder, CO. She received the B.A. degree in English with a minor in psychology from Saginaw Valley State University in 1994. She continued her studies in 2001 in the Master in Education with Initial Certification (M.Ed.) program at Aquinas College, where she received her Secondary Level Teacher Certification.

From 2002 to 2005, she was a teacher in Michigan. From 2006 to 2010, she was the Assistant Editor of the IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES. She currently holds the same position with *IEEE Microwave Magazine*, and also serves as the Publications Administrator for the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

TOPIC EDITORS

René Beigang received the Diploma and Ph.D. degrees from the University of Hannover, Hannover, Germany.

He spent three years as a post-doctorate and visiting scientist at the IBM T. J. Watson Research Center, Yorktown Heights, NY. He was Associate Professor at the Free University of Berlin and the University of Kaiserslautern. He is now a full professor at the Department of Physics of the University of Kaiserslautern. Since 2005, he is also Head of the Department on Terahertz Measurement and Systems of the Fraunhofer Institute for Physical Measurement Techniques. His current research interests include nonlinear optics, generation and application of THz radiation, THz spectroscopy, applications of THz radiation in science and technology, realization and investigation of THz meta materials. (His homepage: http://www.physik.uni-kl.de/beigang).

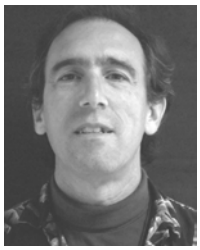
A. Giles Davies received the B.Sc. degree in chemical physics from the University of Bristol, Bristol, U.K., in 1987, and the Ph.D. degree in semiconductor physics from the University of Cambridge, Cambridge, U.K., in 1991.

He is currently Professor of Electronic and Photonic Engineering at the University of Leeds, Leeds, U.K. His research interests concentrate on the electrical and optical properties of low-dimensional and nanostructured electronic systems, and multilayered semiconductor devices, with particular recent focus on the development of terahertz frequency systems and the exploitation of biological processes for nanoscale assembly.

Gian Piero Gallerano received the Laurea degree (Ph.D.) in physics from the University of Rome, Italy, in 1980 with a thesis on the realization of a tunable color center laser in the near infrared.

In 1981, he was a Visiting Fellow at the Technical University Hannover, Germany. In 1983 he joined the High Power Laser Laboratory at ENEA Research Center, Frascati to work on the development of infrared free electron lasers (FEL). In 1991, he was a Visiting Scholar at the Ginzton Laboratory, EE Department, Stanford University. His work on FELs lead to the realization of the ENEA Compact FEL (90–150 GHz) and of the Compact Advanced THz Source, FEL-CATS (0.4–0.7 THz). From 2001 to 2004, he has been the Coordinator of the European project THz-BRIDGE involving ten research institutes in the study the interaction of THz radiation with biological systems. From 2005 to 2007, he was in charge of the ENEA participation in the European project EUROFEL. He is currently the Head of the Radiation Sources Laboratory at ENEA Frascati. His areas of interest include generation of THz radiation and its application in the biological, biomedical, environmental and art conservation fields, THz imaging techniques, coherent emission from RF modulated electron beams, free electron lasers, optical design and diagnostics in the infrared.

Dr. Gallerano organized the "35th International Conference on Infrared, Millimeter and THz Waves" IRMMW-THz 2010 held in Rome, Italy, September 5–10, 2010, and currently chairs the International Society of Infrared, Millimeter and Terahertz Waves, the oldest and largest forum devoted to scientific and technological developments in the wide spectral range extending from the infrared to the millimeter wave region. He has been a member of the Italian Physical Society since 1981, and is a member of the Bioelectromagnetics Society.



Erich N. Grossman received the A.B. degree in physics from Harvard College, Cambridge, MA, in 1980, and a Ph.D. degree, also in physics, from the California Institute of Technology, Pasadena, in 1987. His thesis work involved development of an ultra-low noise, heterodyne receiver for 2 THz astronomy.

From 1988 to 1989, he was a post-doctoral fellow at the University of Texas at Austin, TX, USA, and in 1989, he joined the National Institute of Standards and Technology, Boulder, CO, USA, where he is now a physicist in the Optoelectronics Division. His work at NIST focuses on infrared and submillimeter system development.

Dr. Grossman's notable accomplishments include the development and demonstration of the world's highest frequency, high efficiency lithographic antennas, the world's highest frequency Josephson junctions, (awarded a Department of Commerce Gold Medal in 1993), and early conception and development of the SQUID multiplexer, first enabling large monolithic arrays of superconducting detectors. More recently, he has developed several 0.1–1 THz cameras for security applications. He is also chair of the Metrology Working Group for the DARPA Terahertz Electronics program.

Haewook Han (M'12) received the B.S. and M.S. degrees in electrical engineering from Seoul National University, Seoul, Korea, in 1986 and 1988, respectively, and the Ph.D. degree in electrical engineering from the University of Illinois at Urbana-Champaign, Urbana, IL, USA, in 1995.

He studied low-threshold strained quantum-well heterostructure lasers and two-dimensional photonic crystal semiconductor lasers. At Bell Laboratories, Murray Hill, NJ, USA, from 1995 to 1997, he contributed to the development of 980-nm high-power semiconductor lasers. He is currently Associate Professor of the Department of Electrical and Computer Engineering at the Pohang University of Science and Technology (POSTECH). He co-founded the Korea THz Forum, and served as the Director of the Center for THz Photonics (1998–2000) and the National Laboratory for Nano-THz Photonics (2005–2009). He invented THz plastic photonic crystal fibers for single-mode THz pulse transmission in 2001. His current research interests include THz hydration dynamics of biomolecules, THz quantum interactions, and THz near-field microscopy and spectroscopy.

Peter Uhd Jepsen (M'10) received the M.Sc. degree in physics and chemistry from Odense University, Denmark, in 1994, and the Ph.D. degree in natural sciences from Århus University, Denmark in 1996.

He was at the University of Freiburg, Germany from 1996 to 2004, working with terahertz time-domain spectroscopy. From 2005, he was Associate Professor at the Technical University of Denmark (DTU), and since 2008, Professor and Head of the Terahertz Technologies and Biophotonics group at DTU. In 2008/2009, he was Visiting Professor at Osaka University. His research areas include photonics-based THz technology, broadband THz spectroscopy for chemical sensing, imaging, chemistry, and water dynamics in the THz range, and time-resolved THz spectroscopy of ultrafast phenomena in the THz range.

Kodo Kawase received the B.S. degree in electronic engineering from Kyoto University in 1989, Japan, and the Ph.D. degree in electronic engineering from Tohoku University, Japan, in 1996.

He became an Initiative Researcher at RIKEN in 2001 and a Professor in the Graduate School of Engineering, Nagoya University, Japan, in 2005. He has been conducting research activities in several directions within the THz field. Professor Kawase developed several types of widely tunable THz sources using nonlinear optical effects, and implemented them for a wide range of real-life applications. He has published more than 130 articles in the THz field and has given more than 160 invited talks on this subject.

Dr. Kawase received the 1997 Young Scientist Award from the JSAP, the 1998 Excellent Presentation Award, the 2000 and 2006 Prize of Laser Engineering from the Laser Society of Japan, the 2002 Marubun research and encouragement award and the 2006 Marubun Special Research Award from the Marubun Research Promotion Foundation (MRPF), and the 2005 Young Scientists' Prize by the Commendation for Science and Technology of the Minister of Education, Culture, Science and Technology (MEXT).

Nuria Llombart received the Electrical Engineering degree and Ph.D. degree from the Polytechnic University of Valencia, Spain, in 2002 and 2006, respectively.

During her Masters' degree studies she spent one year at the Friedrich-Alexander University of Erlangen-Nuremberg, Germany, and worked at the Fraunhofer Institute for Integrated Circuits, Erlangen, Germany. From 2002 until 2007, she was with the Antenna Group at the TNO Defence, Security and Safety Institute, The Hague, The Netherlands, working as a Ph.D. student and afterwards as a researcher. From 2007 until 2010, she was a Post-Doctoral Fellow at the California Institute of Technology, working for the Sub millimeter Wave Advance Technology group of the Jet Propulsion Laboratory (JPL), Pasadena, CA, USA. From 2010 to 2012, she held a "Ramón y Cajal" fellowship at the Optics Department of the Complutense University of Madrid, Spain. She recently relocated to Technical University of Delft, Netherlands, where she is a professor in the Electrical Engineering department, and she continues to be an affiliate at JPL, Pasadena. Her research interests include the analysis and design of planar antennas, periodic structures, reflector antennas, lens antennas, waveguide structures, with emphasis in the THz range.

Dr. Llombart was co-recipient of the H. A. Wheeler Award for the Best Applications Paper of 2008 in the IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION. She was also a co-recipient of an Honorable Mention at the 2010 European Conference of Antennas.

Victor M. Lubecke received the B.S.E.E. degree from the California State Polytechnic Institute, Pomona, CA, USA, in 1986, and the M.S. and Ph.D. degrees in electrical engineering from the California Institute of Technology, Pasadena, CA, USA, in 1990 and 1995, respectively.

He is currently a professor of Electrical Engineering at the University of Hawaii, Manoa, HI, USA. From 1998 to 2003, Dr. Lubecke was with Bell Laboratories, Lucent Technologies, where his research focused on remote sensing technologies for biomedical and industrial applications, and on microelectromechanical systems (MEMS) and 3-D wafer-scale integration technologies for wireless and optical communications. From 1987 through 1996, he was with the NASA Jet Propulsion Laboratory (JPL), and from 1996 to 1998, he was with the Institute for Physical and Chemical Research (RIKEN), Sendai, Japan, where his research involved terahertz and MEMS technologies for space remote sensing and communications applications. He holds six U.S. patents with several pending, and has published over 150 peer-reviewed research articles.

Prof. Lubecke is an emeritus Distinguished Microwave Lecturer (2006–2008) of the IEEE Microwave Theory and Techniques Society, and was a co-recipient of the Emerging Technology Award at TechConnect 2007. He co-founded and served as CTO for a start-up company that is now Kai Medical, Honolulu, HI. His current research interests include remote sensing technologies, biomedical sensors, MEMS, heterogeneous integration, and microwave/terahertz radio.

Imran Mehdi (S'83–M'90–SM'09–F'10) received the B.S.E.E. degree in 1985, the M.S.E.E. degree in 1986, and the Ph.D. degree in 1990, all from the University of Michigan.

He is currently Principal Member of Engineering staff at the Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA, and Supervisor of the JPL Submillimeter-Wave advanced Technology (SWAT) team. His responsibilities include developing THz components and subsystems for current and future NASA missions. He joined JPL in 1990 where his first task included the design and fabrication of low-parasitic planar Schottky diodes for submillimeter-wave applications. These devices were implemented on the ozone monitoring Microwave Limb Sounder instrument launched in 2004, as well as the MIRO instrument which represents the first submillimeter-wave receiver that will rendezvous with a comet in 2014. From 1999, he led the effort of developing broadband solid-state sources from 200 to 2500 GHz for the Heterodyne Instrument for Far Infrared (HIFI) on the Herschel Space Observatory, a cornerstone European Space Agency mission currently in space. This effort led to realization of wide-band solid-state sources in the THz range enabling ground-breaking astrophysics observations in space as well as at many ground-based observatories. His current interests include both mm and sub-mm wave devices, semiconductor fabrication technology, high-frequency instrumentation, and heterodyne receivers for miniature systems.

Alexander Shkurinov graduated in 1985 with honors from the Department of Physics of M.V. Lomonosov Moscow State University (MSU), and received the Ph.D. degree in physics from MSU in 1988.

In 1989, he became Research Scientist at the R.V. Khohlov Laboratory of Non-Linear Optics at MSU. His research interests are centered on the development and application of femtosecond laser techniques, time-resolved spectroscopy of molecules in the liquid phase, nonlinear optics and terahertz techniques and spectroscopy.

Dr. Shkurinov has participated in a wide range of scientific advisory boards and sat on the organizing and program committees of numerous international conferences. He was awarded the Rozhdestvensky Medal from the Russian Optical Society for his contribution into the development of optical science and technology in 2008.

Jan Stake (M'95) received the M.Sc. degree in electrical engineering and the Ph.D. degree in microwave electronics from Chalmers University of Technology, Göteborg, Sweden, in 1994 and 1999, respectively.

In 1997, he was a Research Assistant at the University of Virginia, Charlottesville, VA, USA. From 1999 to 2001, he was a Research Fellow in the millimeter wave group at the Rutherford Appleton Laboratory, U.K. He then joined Saab Combitech Systems AB as a Senior RF/microwave Engineer until 2003. From 2000 to 2006, he held different academic positions at Chalmers and was also Head of the Nanofabrication Laboratory at MC2 between 2003 and 2006. During 2007, he was a Visiting Professor in the Submillimeter Wave Advanced Technology (SWAT) group at Caltech/JPL, exploring THz applications in biology and medicine. He is currently Professor and Head of the Terahertz and Millimetre Wave Laboratory, Chalmers, Sweden. His research involves terahertz sources, detectors and mixers, high frequency semiconductor devices, graphene electronics, terahertz measurement techniques and applications.

Christopher Walker has over 25 years experience designing, building, and using state-of-the-art receiver systems for THz astronomy. He is a Professor of Astronomy and an Associate Professor of Optical Sciences and Electrical Engineering at the University of Arizona (U of A). He has worked in industry (TRW Aerospace and JPL) as well as academia. As a Millikan Fellow in Physics at Caltech, he worked on the development of low-noise, SIS waveguide receivers above 400 GHz and explored techniques for etching waveguide out of silicon. On joining the U of A faculty in 1991 he began the Steward Observatory Radio Astronomy Lab (SORAL), which has become a world leader in developing THz receiver systems for astronomy and other remote sensing applications. These instruments are multi-institutional efforts, with key components coming from JPL, several universities, and a number of industrial partners. He manages and coordinates these efforts. Instruments developed by Prof. Walker's team have served as primary facility instruments at the Heinrich Hertz Telescope on Mt. Graham, AZ, USA, and the AST/RO telescope at the South Pole. He is leading the effort to design and build the world's largest (64 pixels) submillimeter-wave heterodyne array receiver (SuperCam). He is also PI of the NASA funded long duration balloon project "The Stratospheric THz Observatory (STO)". He has published numerous papers on star formation and protostellar evolution. He has served as dissertation director for nine Ph.D. students.

Vincent Wallace received the Ph.D. degree in medical physics from the University of London, London, U.K., in 1997.

He has nearly 20 years of experience in Biophotonics. After four years as a post doctorate at the Beckman Laser Institute and Medical Clinic, University of California, Irvine, CA, USA, he joined Toshiba Research in Cambridge, U.K., to look at potential applications of terahertz radiation. The terahertz group was spun-out of Toshiba Labs in April 2001 and became TeraView Ltd, also based in Cambridge. At TeraView, he led a group investigation the biomedical applications of terahertz technology. In 2007, he moved to the University of Western Australia to take up a full time academic role where he continues to apply terahertz and other optical techniques to biomedical and clinical problems and the understanding of the interaction of electromagnetic radiation with tissues.

Closing Editorial

WELCOME to our last issue in Volume 5 of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY. There is a lot to relay this month, including some results from our THz Origins contest, upcoming special issues in 2016, the end of our regular *THz Pioneer* series, and the introduction of a new Editor-in-Chief for these Transactions. In addition, we have a very full regular paper queue for November, as well as a Special Mini-Issue containing translated and updated papers from the Japanese *Journal of the IEICE* (Institute of Electronics, Information and Communication Engineers).

THz Origins

As far as this Editor-in-Chief is aware of, the first use of the term "THz" in an MTT Society journal publication appeared in an article by J. W. Fleming entitled, "High resolution submillimeter-wave Fourier-transform spectroscopy of gases," *IEEE Trans. Microw. Theory Techn.*, vol. MTT-22, no. 12, pp. 1023–1025, Dec. 1974. Appropriately, the article title refers to the frequency regime that we now prefer to designate as "THz", using the more historically popular designation "submillimeter-wave." The rise of the now prolific term "THz" in association with the rise in popularity of the field in general, is rather intriguing. As such, I was interested to find out if other researchers had references to even earlier uses of the term "THz" in the literature, either in English or its equivalent term in other languages.

Several people responded to our "Request for Information" with some interesting historic references. The date to beat for an English language book publication (rather than a journal article) is now 1964. The EiC thanks Professor Derek Abbott of University of Adelaide, Australia, for this citation. The book is a compilation of papers from a proceedings edited by none other than Charles Hard Townes and Perry Ambrose Miles, "Quantum electronics and coherent light," *Proc. Int. School of Physics*, Enrico Fermi course XXXI, Varenna on Lake Como, August 19–31, 1963. Within the text there is a prominent chapter by Z. Bay and H. S. Boyne titled, "The use of Terahertz Photobeats for Precise Velocity-of-Light Measurements." There are several other uses of the term terahertz in other parts of the proceedings.

The term "teracycles" is officially defined, along with the convention of replacing "cycles" by "hertz," maybe for the first time, in an IRE reference from 1959 by William Watkins of the U.S. Federal Communications Commission (FCC) where he states on page 6 of the article (the EiC again thanks Derek Abbott for this reference):

> "Another change in terminology is adoption of "gigacycles" to mean one billion cycles and "teracycles" to mean one trillion cycles. For example, henceforth any frequency higher than 3000 Mc/s should be expressed in gigacycles. Thus, 3000 Mc/s becomes 3 Gc/s. Still another change in terminology is the use of the word "Hertz" as a substitute for cycles per second (c/s). In most parts of the world where English is not the principal language, the use of Hertz and its multiples, "kHz", "MHz", and "GHz", becomes standard, based on the French text." (Ref.: W. H. Watkins, "Report on World Radio Conference, Geneva, Switzerland, 1959," *IRE Trans. Broadcasting*, vol. 2, no. 1, pp. 3–7, 1960.)

Perhaps referring back to the French convention, the definition of the term "terahertz" appears (in French) in the introduction to a compilation of molecular spectroscopy journal issues, "Spectroscopia Molecular, volumes 5–10," by Forest Fenton Cleveland, Editor, in 1956—a reference also submitted by Derek Abbott.

A couple of additional references came in from Dr. Jean-François Lampin, of the Chargé de Recherche CNRS, Villeneuve d'Ascq, France, citing a 1967 Masters thesis from University of British Columbia, Canada, by Vishnu Sahay defining the submillimeter as 0.3–3 THz, and the conversion of 8000 GHz to 8 THz in a French paper on Josephson junctions in *Revue de Physique Appliquée*, vol. 6, no. 4, pp. 535–542, by T. Pech in 1971. Interestingly, in Japan, where THz is a very popular research topic today, a program led by Jun-ichi Nishizawa[1] had the English title "Nishizawa Terahertz" under the ERATO (Exploratory Research for Advanced Technology) project in 1987, perhaps the earliest official government use of the term in that country (the EiC thanks Professor Koji Mizuno of Tohoku University for this reference).

If anyone would like to challenge, or add to our current list with an earlier reference to "THz" or "terahertz", or the use of this terminology in other languages, please send me a note (phs@caltech.edu)!

November Issue Papers

Moving on to our current issue, we have 25 regular contributed papers covering topics from broad band infrared detectors to graphene-based waveguides to THz biomedical effects and much more. Rather than list these papers individually, the reader is referred to the lengthy Table of Contents this month. Note that this will be our largest single issue release since the journal began in September 2011! We also have 2 shorter papers in our *THz Letters* section to look over. Our THz Pioneer article this month—the last of the official series—is on atmospheric scientist Joe W. Waters, whose contributions involving high-frequency narrow-band spectral line measurements in the stratosphere and upper troposphere are the very definition of a "killer" application for this frequency regime. I am fairly certain this 26th article in our series will leave you with a strong

[1]See P. H. Siegel, "THz Pioneer: Jun-Ichi Nishizawa—THz Shogun," *IEEE Trans. THz Sci. Technol.*, vol. 5, no. 2, pp. 161–169, 2015. (ERATO reference on page 165).

Digital Object Identifier 10.1109/TTHZ.2015.2491642

positive feeling about the value of THz science for questions of global concern. The article is appropriately titled "*THz Meets Gaia*".

Special Issue Papers

Trailing our regular contributions, we are following through on a project we have contemplated since almost the start of this journal—publishing articles that have appeared exclusively in another language, but that would benefit the THz community if they were to be presented in English. Last November, the Institute of Electronics, Information and Communication Engineers (IEICE) of Japan released a special issue of the *Journal of IEICE*[2] that focused on Terahertz Applications. After early discussions with two of the authors involved in the IEICE special issue articles, Dr. Naoya Kukutsu and Dr. Tadao Nagatsuma, we decided to try and put together an English language version of the IEICE release. The project turned out to be much more complicated than was originally envisioned by this EIC, but nevertheless we have prevailed. This Special Mini-Issue includes 11 of the original 14 articles, with translations and amendments that are targeted specifically for the audience that regularly reads this THz TRANSACTIONS. You will find these articles, and a special introduction, immediately after the last of our *THz Letters* in a separate section we have titled: "Special Mini-Issue on THz Applications: Translated and Updated Papers from the Institute of Electronics, Information and Communication Engineers (IEICE)."

Coming up in January 2016 is our Special Mini-Issue covering expanded papers from the 25th *International Symposium on Space Terahertz Technology (ISSTT)* that took place last spring at Harvard University, Boston, MA, USA. We also have a special issue in the works on *Terahertz Nanomaterials and Applications* scheduled for late spring–early summer (see the Call for Papers on page 288 of our March 2015 issue).

New EiC

Beginning in January 2016, this Ttransactions will have a new Editor-in-Chief, who is tasked will guiding the journal through the next three years. I would like to welcome Professor Jan Stake, of Chalmers University, Gothenburg, Sweden, to this role, and offer my personal thanks and my own best wishes for a very successful term. Professor Stake's biography is contained within our Topical Editors (TE) biographies following this Editorial.

EIC Reminiscences

As this will be my last Editorial, and my last communications as Editor-in-Chief, I would like to spend a moment to look back over the last few years and highlight a few of the events that have brought us to this point.

The journal started with only a name and approval of the topic area by the IEEE and the MTT Society AdCom, in the summer of 2010, when the EiC was brought on. The scope, logo, slogan, cover appearance, editorial structure, paper policies and procedures, web site and preferred article focus were all developed from scratch within the first month. Despite the backing from a mostly engineering society, the EiC pledged to expand the outreach and content to fields outside traditional microwave circuits and systems, and to encompass physics, optics, chemistry, biology and any other research areas that involved THz science or technology. In the fall of 2010, the EiC brought on board 13 internationally recognized "Topic Editors" who spanned a wide range of disciplines and geographic areas, and who volunteered to help realize these broad reaching goals.

Our paper submission site went live in October 2010, and we released our very well received Inaugural issue (September 2011) less than one year later. We started with an email paper handling process, but were fully converted over to an all-electronic-input paper handling system by May 2011, well before the release of our opening issue. By the end of year one, we were able to put in place an annual review process, and to announce a "THz Best Paper" award and—a first for MTT Society at least—a "THz Best Reviewer" award. We began our first paid subscriptions in 2013—the same year we finally began to be indexed on Reuters' *Web of Science*. Before this point, authors could only find their published papers through IEEE Xplore. We were rewarded in July of 2013 with the highest Impact Factor ever achieved by an MTT Society publication—4.34, and were even more excited to learn that the journal was ranked in the top 5% of all journals in Electrical Engineering (12th out of 247), the top 12% of all *Applied Physics* journals (17th out of 136), and the top 6% of all journals in *Optics* (5th out of 82). As a result, we were also the first IEEE journal to officially implement a formal prescreening process for submitted manuscripts!

In order to serve the widest possible THz community, we have employed several unusual strategies, including the introduction of the *THz Pioneers* series to help bridge the historic background gap between THz electronics and THz photonics professionals, and to stimulate the interests of incoming and younger members of our THz family. We experimented with special "Mini-issues"—selected focused topics within the regular print issue—to add some current content from conferences or special topics considered particularly relevant to the THz community. We started a short paper section—*THz Letters*—at the beginning of 2014 in response to requests from our authors to have an outlet for less lengthy articles. We have built up a large cadre of THz reviewers—young and old—through events and outreach, and we have tried to treat our authors as our valued customers—giving them as much respect and personal attention as we can muster. You deserve no less.

Thank You

For all of this, I would like to express my most sincere thanks to those who have contributed to the establishment, growth and success of these transactions—all of whom are volunteers. I especially appreciate the time and devotion of our numerous and dedicated Reviewers, and most of all, our Topic Editors, many of whom have been with the journal from the very beginning: *Stefano Alberti, Rene Beigang, Alexander Giles Davies, Jack East, Gian Piero Gallerano, Erich Grossman, Haewook Han, Peter Uhd Jepsen, Kodo Kawase, Martin Koch, Nuria*

[2]This issue of the *IEICE Transactions on Electronics* appeared in November 2014 as vol. 97, no. 11, under the special issue title, "Special Issue on Advanced Terahertz Technologies and Efforts toward Practical Applications." A link to the contents (in English) can be found at: http://www.journal.ieice.org/archive.php?vol=97&num=11&year=2014&lang=E

Llombart-Juan, Victor Lubecke, Imran Mehdi, Gun-Sik Park, Alex Shkurinov, Jan Stake, Chris Walker, and Vince Wallace. Also a special thank you to *Dylan Williams*, our founding Executive Editor; *Sharri Shaw*, our constant Administrative Editor; Frank Maiwald, our publicity chair; and *Mona Mittra*, our valued IEEE Publications Editor.

I also very much appreciate and wholeheartedly thank all of you who have contributed articles, even before we were widely indexed, and before we had an Impact Factor, and those of you who helped us with special issues and special invited papers. This first-of-its-kind exclusively "THz" transactions owes its existence and its success totally to your support as readers and citers of its content, and to your continued loyalty as authors and contributors of significant research results. I hope you all find your future interactions with the editors and staff supporting the journal highly satisfactory, and I sincerely wish all of you success with your THz research and with your own careers.

It has been my greatest pleasure to serve the THz community these last five years, and I am grateful to all of you who have made my time as Editor-in-Chief both challenging and enjoyable. Thank you, I will remain forever grateful.

Now turn the page to start Volume 5, Issue 6 of IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

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Peter H. Siegel (S'75–M'83–SM'98–F'01) received the B.A. degree from Colgate University, Hamilton, NY, in 1976, and the Ph.D. degree from Columbia University, New York, NY, USA, in 1983.

He held appointments as Faculty Associate in Electrical Engineering and Senior Scientist in Biology at Caltech, Pasadena, CA, USA, and Senior Research Scientist and Technical Group Supervisor for Submillimeter Wave Advanced Technology (SWAT) at the Jet Propulsion Laboratory (JPL) in Pasadena, CA, USA, for more than 25 years. He retired from these positions in September 2013 in order to focus on a small R&D company he started, THz Global. He is also continuing his affiliation at Caltech as a Visiting Faculty member in the Electrical Engineering Department.

Dr. Siegel has PI'd or co-I'd more than 75 R&D programs and been involved in four major space flight instruments. He has published more than 300 articles in the THz field, and has given more than 200 invited talks in the U.S. and abroad on this subject. At JPL, he led a group of 25+ research scientists and engineers developing THz technology for NASA's near and long term space missions as well as for several Department of Defense (DoD) applications. At Caltech, he has been involved in new biological and medical applications of THz. His current interests are focused on THz applications in medicine and biology. He has been extremely pleased, and very excited to be a part of the formation and growth of the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

Among many other duties, Dr. Siegel serves as elected General Secretary of the International Society for Infrared, Millimeter, and Terahertz Waves (IRMMW-THz), the oldest and largest venue devoted to the field of far IR techniques, science and applications, and he served as conference organizer and chair for IRMMW-THz 2008 in Pasadena and IRMMW-THz 2014 in Tucson, AZ. He also founded, incorporated and served as first President of the International Society of Infrared, Millimeter, and Terahertz Waves. Dr. Siegel has served as an IEEE Distinguished Microwave Lecturer, co-Chair and Chair of MTT Committee 4—THz Technology, a TPC and Speaker's bureau member, and as organizer and chair of seven special sessions at the IEEE International Microwave Symposia. For the past 5 years, Dr. Siegel has had the great privilege to serve as an Ad-hoc member of the MTTS AdCom where he has learned from, and grown to admire the many professional volunteers that play such an enormous role in guiding this unique IEEE society and in particular, these THz TRANSACTIONS.

ADMINISTRATIVE EDITOR

Sharri Shaw was born in Michigan, and currently resides in Boulder, CO. She received the B.A. degree in English with a minor in psychology from Saginaw Valley State University in 1994. She continued her studies in 2001 in the Master in Education with Initial Certification (M.Ed.) program at Aquinas College, where she received her Secondary Level Teacher Certification.

From 2002 to 2005, she was a teacher in Michigan. From 2006 to 2010, she was the Assistant Editor of the IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES. She currently holds the same position with *IEEE Microwave Magazine*, and also serves as the Publications Administrator for the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY.

TOPIC EDITORS

René Beigang received the Diploma and Ph.D. degrees from the University of Hannover, Hannover, Germany.

He spent three years as a post-doctorate and visiting scientist at the IBM T. J. Watson Research Center, Yorktown Heights, NY. He was Associate Professor at the Free University of Berlin and the University of Kaiserslautern. He is now a full professor at the Department of Physics of the University of Kaiserslautern. Since 2005, he is also Head of the Department on Terahertz Measurement and Systems of the Fraunhofer Institute for Physical Measurement Techniques. His current research interests include nonlinear optics, generation and application of THz radiation, THz spectroscopy, applications of THz radiation in science and technology, realization and investigation of THz meta materials. (His homepage: http://www.physik.uni-kl.de/beigang).

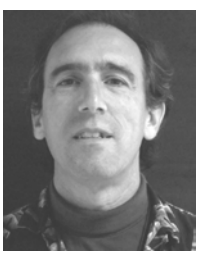
A. Giles Davies received the B.Sc. degree in chemical physics from the University of Bristol, Bristol, U.K., in 1987, and the Ph.D. degree in semiconductor physics from the University of Cambridge, Cambridge, U.K., in 1991.

He is currently Professor of Electronic and Photonic Engineering at the University of Leeds, Leeds, U.K. His research interests concentrate on the electrical and optical properties of low-dimensional and nanostructured electronic systems, and multilayered semiconductor devices, with particular recent focus on the development of terahertz frequency systems and the exploitation of biological processes for nanoscale assembly.

Gian Piero Gallerano received the Laurea degree (Ph.D.) in physics from the University of Rome, Italy, in 1980 with a thesis on the realization of a tunable color center laser in the near infrared.

In 1981, he was a Visiting Fellow at the Technical University Hannover, Germany. In 1983 he joined the High Power Laser Laboratory at ENEA Research Center, Frascati to work on the development of infrared free electron lasers (FEL). In 1991, he was a Visiting Scholar at the Ginzton Laboratory, EE Department, Stanford University. His work on FELs lead to the realization of the ENEA Compact FEL (90–150 GHz) and of the Compact Advanced THz Source, FEL-CATS (0.4–0.7 THz). From 2001 to 2004, he has been the Coordinator of the European project THz-BRIDGE involving ten research institutes in the study the interaction of THz radiation with biological systems. From 2005 to 2007, he was in charge of the ENEA participation in the European project EUROFEL. He is currently the Head of the Radiation Sources Laboratory at ENEA Frascati. His areas of interest include generation of THz radiation and its application in the biological, biomedical, environmental and art conservation fields, THz imaging techniques, coherent emission from RF modulated electron beams, free electron lasers, optical design and diagnostics in the infrared.

Dr. Gallerano organized the "35th International Conference on Infrared, Millimeter and THz Waves" IRMMW-THz 2010 held in Rome, Italy, September 5–10, 2010, and currently chairs the International Society of Infrared, Millimeter and Terahertz Waves, the oldest and largest forum devoted to scientific and technological developments in the wide spectral range extending from the infrared to the millimeter wave region. He has been a member of the Italian Physical Society since 1981, and is a member of the Bioelectromagnetics Society.



Erich N. Grossman received the A.B. degree in physics from Harvard College, Cambridge, MA, in 1980, and a Ph.D. degree, also in physics, from the California Institute of Technology, Pasadena, in 1987. His thesis work involved development of an ultra-low noise, heterodyne receiver for 2 THz astronomy.

From 1988 to 1989, he was a post-doctoral fellow at the University of Texas at Austin, TX, USA, and in 1989, he joined the National Institute of Standards and Technology, Boulder, CO, USA, where he is now a physicist in the Optoelectronics Division. His work at NIST focuses on infrared and submillimeter system development.

Dr. Grossman's notable accomplishments include the development and demonstration of the world's highest frequency, high efficiency lithographic antennas, the world's highest frequency Josephson junctions, (awarded a Department of Commerce Gold Medal in 1993), and early conception and development of the SQUID multiplexer, first enabling large monolithic arrays of superconducting detectors. More recently, he has developed several 0.1–1 THz cameras for security applications. He is also chair of the Metrology Working Group for the DARPA Terahertz Electronics program.

Haewook Han (M'12) received the B.S. and M.S. degrees in electrical engineering from Seoul National University, Seoul, Korea, in 1986 and 1988, respectively, and the Ph.D. degree in electrical engineering from the University of Illinois at Urbana-Champaign, Urbana, IL, USA, in 1995.

He studied low-threshold strained quantum-well heterostructure lasers and two-dimensional photonic crystal semiconductor lasers. At Bell Laboratories, Murray Hill, NJ, USA, from 1995 to 1997, he contributed to the development of 980-nm high-power semiconductor lasers. He is currently Associate Professor of the Department of Electrical and Computer Engineering at the Pohang University of Science and Technology (POSTECH). He co-founded the Korea THz Forum, and served as the Director of the Center for THz Photonics (1998–2000) and the National Laboratory for Nano-THz Photonics (2005–2009). He invented THz plastic photonic crystal fibers for single-mode THz pulse transmission in 2001. His current research interests include THz hydration dynamics of biomolecules, THz quantum interactions, and THz near-field microscopy and spectroscopy.

Peter Uhd Jepsen (M'10) received the M.Sc. degree in physics and chemistry from Odense University, Denmark, in 1994, and the Ph.D. degree in natural sciences from Århus University, Denmark in 1996.

He was at the University of Freiburg, Germany from 1996 to 2004, working with terahertz time-domain spectroscopy. From 2005, he was Associate Professor at the Technical University of Denmark (DTU), and since 2008, Professor and Head of the Terahertz Technologies and Biophotonics group at DTU. In 2008/2009, he was Visiting Professor at Osaka University. His research areas include photonics-based THz technology, broadband THz spectroscopy for chemical sensing, imaging, chemistry, and water dynamics in the THz range, and time-resolved THz spectroscopy of ultrafast phenomena in the THz range.

Kodo Kawase received the B.S. degree in electronic engineering from Kyoto University in 1989, Japan, and the Ph.D. degree in electronic engineering from Tohoku University, Japan, in 1996.

He became an Initiative Researcher at RIKEN in 2001 and a Professor in the Graduate School of Engineering, Nagoya University, Japan, in 2005. He has been conducting research activities in several directions within the THz field. Professor Kawase developed several types of widely tunable THz sources using nonlinear optical effects, and implemented them for a wide range of real-life applications. He has published more than 130 articles in the THz field and has given more than 160 invited talks on this subject.

Dr. Kawase received the 1997 Young Scientist Award from the JSAP, the 1998 Excellent Presentation Award, the 2000 and 2006 Prize of Laser Engineering from the Laser Society of Japan, the 2002 Marubun research and encouragement award and the 2006 Marubun Special Research Award from the Marubun Research Promotion Foundation (MRPF), and the 2005 Young Scientists' Prize by the Commendation for Science and Technology of the Minister of Education, Culture, Science and Technology (MEXT).

Nuria Llombart received the Electrical Engineering degree and Ph.D. degree from the Polytechnic University of Valencia, Spain, in 2002 and 2006, respectively.

During her Masters' degree studies she spent one year at the Friedrich-Alexander University of Erlangen-Nuremberg, Germany, and worked at the Fraunhofer Institute for Integrated Circuits, Erlangen, Germany. From 2002 until 2007, she was with the Antenna Group at the TNO Defence, Security and Safety Institute, The Hague, The Netherlands, working as a Ph.D. student and afterwards as a researcher. From 2007 until 2010, she was a Post-Doctoral Fellow at the California Institute of Technology, working for the Sub millimeter Wave Advance Technology group of the Jet Propulsion Laboratory (JPL), Pasadena, CA, USA. From 2010 to 2012, she held a "Ramón y Cajal" fellowship at the Optics Department of the Complutense University of Madrid, Spain. She recently relocated to Technical University of Delft, Netherlands, where she is a professor in the Electrical Engineering department, and she continues to be an affiliate at JPL, Pasadena. Her research interests include the analysis and design of planar antennas, periodic structures, reflector antennas, lens antennas, waveguide structures, with emphasis in the THz range.

Dr. Llombart was co-recipient of the H. A. Wheeler Award for the Best Applications Paper of 2008 in the IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION. She was also a co-recipient of an Honorable Mention at the 2010 European Conference of Antennas.

Victor M. Lubecke received the B.S.E.E. degree from the California State Polytechnic Institute, Pomona, CA, USA, in 1986, and the M.S. and Ph.D. degrees in electrical engineering from the California Institute of Technology, Pasadena, CA, USA, in 1990 and 1995, respectively.

He is currently a professor of Electrical Engineering at the University of Hawaii, Manoa, HI, USA. From 1998 to 2003, Dr. Lubecke was with Bell Laboratories, Lucent Technologies, where his research focused on remote sensing technologies for biomedical and industrial applications, and on microelectromechanical systems (MEMS) and 3-D wafer-scale integration technologies for wireless and optical communications. From 1987 through 1996, he was with the NASA Jet Propulsion Laboratory (JPL), and from 1996 to 1998, he was with the Institute for Physical and Chemical Research (RIKEN), Sendai, Japan, where his research involved terahertz and MEMS technologies for space remote sensing and communications applications. He holds six U.S. patents with several pending, and has published over 150 peer-reviewed research articles.

Prof. Lubecke is an emeritus Distinguished Microwave Lecturer (2006–2008) of the IEEE Microwave Theory and Techniques Society, and was a co-recipient of the Emerging Technology Award at TechConnect 2007. He co-founded and served as CTO for a start-up company that is now Kai Medical, Honolulu, HI. His current research interests include remote sensing technologies, biomedical sensors, MEMS, heterogeneous integration, and microwave/terahertz radio.

Imran Mehdi (S'83–M'90–SM'09–F'10) received the B.S.E.E. degree in 1985, the M.S.E.E. degree in 1986, and the Ph.D. degree in 1990, all from the University of Michigan.

He is currently Principal Member of Engineering staff at the Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA, and Supervisor of the JPL Submillimeter-Wave advanced Technology (SWAT) team. His responsibilities include developing THz components and subsystems for current and future NASA missions. He joined JPL in 1990 where his first task included the design and fabrication of low-parasitic planar Schottky diodes for submillimeter-wave applications. These devices were implemented on the ozone monitoring Microwave Limb Sounder instrument launched in 2004, as well as the MIRO instrument which represents the first submillimeter-wave receiver that will rendezvous with a comet in 2014. From 1999, he led the effort of developing broadband solid-state sources from 200 to 2500 GHz for the Heterodyne Instrument for Far Infrared (HIFI) on the Herschel Space Observatory, a cornerstone European Space Agency mission currently in space. This effort led to realization of wide-band solid-state sources in the THz range enabling ground-breaking astrophysics observations in space as well as at many ground-based observatories. His current interests include both mm and sub-mm wave devices, semiconductor fabrication technology, high-frequency instrumentation, and heterodyne receivers for miniature systems.

Alexander Shkurinov graduated in 1985 with honors from the Department of Physics of M.V. Lomonosov Moscow State University (MSU), and received the Ph.D. degree in physics from MSU in 1988.

In 1989, he became Research Scientist at the R.V. Khohlov Laboratory of Non-Linear Optics at MSU. His research interests are centered on the development and application of femtosecond laser techniques, time-resolved spectroscopy of molecules in the liquid phase, nonlinear optics and terahertz techniques and spectroscopy.

Dr. Shkurinov has participated in a wide range of scientific advisory boards and sat on the organizing and program committees of numerous international conferences. He was awarded the Rozhdestvensky Medal from the Russian Optical Society for his contribution into the development of optical science and technology in 2008.

Jan Stake (M'95) received the M.Sc. degree in electrical engineering and the Ph.D. degree in microwave electronics from Chalmers University of Technology, Göteborg, Sweden, in 1994 and 1999, respectively.

In 1997, he was a Research Assistant at the University of Virginia, Charlottesville, VA, USA. From 1999 to 2001, he was a Research Fellow in the millimeter wave group at the Rutherford Appleton Laboratory, U.K. He then joined Saab Combitech Systems AB as a Senior RF/microwave Engineer until 2003. From 2000 to 2006, he held different academic positions at Chalmers and was also Head of the Nanofabrication Laboratory at MC2 between 2003 and 2006. During 2007, he was a Visiting Professor in the Submillimeter Wave Advanced Technology (SWAT) group at Caltech/JPL, exploring THz applications in biology and medicine. He is currently Professor and Head of the Terahertz and Millimetre Wave Laboratory, Chalmers, Sweden. His research involves terahertz sources, detectors and mixers, high frequency semiconductor devices, graphene electronics, terahertz measurement techniques and applications. Prof. Stake takes over as Editor-in-Chief of the IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY starting January 1, 2016.

Christopher Walker has over 25 years experience designing, building, and using state-of-the-art receiver systems for THz astronomy. He is a Professor of Astronomy and an Associate Professor of Optical Sciences and Electrical Engineering at the University of Arizona (U of A). He has worked in industry (TRW Aerospace and JPL) as well as academia. As a Millikan Fellow in Physics at Caltech, he worked on the development of low-noise, SIS waveguide receivers above 400 GHz and explored techniques for etching waveguide out of silicon. On joining the U of A faculty in 1991 he began the Steward Observatory Radio Astronomy Lab (SORAL), which has become a world leader in developing THz receiver systems for astronomy and other remote sensing applications. These instruments are multi-institutional efforts, with key components coming from JPL, several universities, and a number of industrial partners. He manages and coordinates these efforts. Instruments developed by Prof. Walker's team have served as primary facility instruments at the Heinrich Hertz Telescope on Mt. Graham, AZ, USA, and the AST/RO telescope at the South Pole. He is leading the effort to design and build the world's largest (64 pixels) submillimeter-wave heterodyne array receiver (SuperCam). He is also PI of the NASA funded long duration balloon project "The Stratospheric THz Observatory (STO)". He has published numerous papers on star formation and protostellar evolution. He has served as dissertation director for nine Ph.D. students.

Vincent Wallace received the Ph.D. degree in medical physics from the University of London, London, U.K., in 1997.

He has nearly 20 years of experience in Biophotonics. After four years as a post doctorate at the Beckman Laser Institute and Medical Clinic, University of California, Irvine, CA, USA, he joined Toshiba Research in Cambridge, U.K., to look at potential applications of terahertz radiation. The terahertz group was spun-out of Toshiba Labs in April 2001 and became TeraView Ltd, also based in Cambridge. At TeraView, he led a group investigation the biomedical applications of terahertz technology. In 2007, he moved to the University of Western Australia to take up a full time academic role where he continues to apply terahertz and other optical techniques to biomedical and clinical problems and the understanding of the interaction of electromagnetic radiation with tissues.