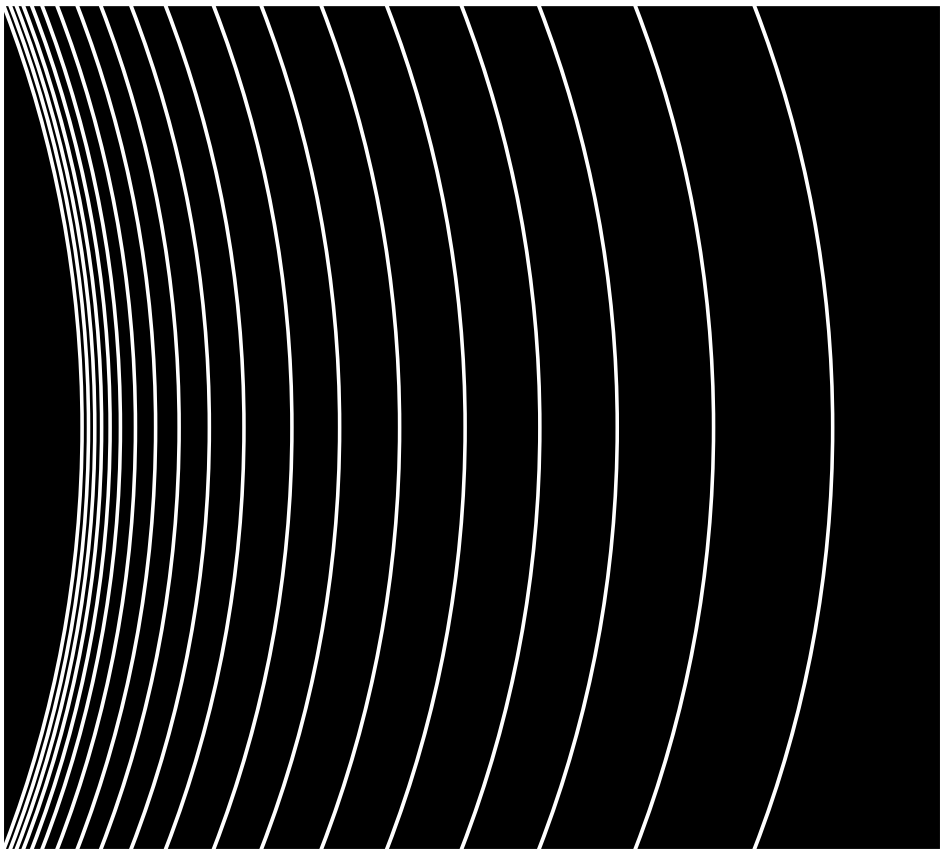
50th Anniversary

# USNC-URSI National Radio Science Meeting

The National Academies of SCIENCES ENGINEERING MEDICINE

U.S. National Committee for the International Union of Radio Science



**9–12 January 2024**

Boulder, Colorado, USA

Sponsored by the US National Committee for the

International Union of Radio Science

and CU Conference Services,

**University of Colorado Boulder**

www.nrsmboulder.org

# UNITED STATES NATIONAL COMMITTEE
# INTERNATIONAL UNION OF RADIO SCIENCE

## National Radio Science Meeting
## 9–12 January 2024
## University of Colorado Boulder

### Meetings and Events Overview

TUESDAY, 9 January

| | |
|---|---|
| 08:30 – 11:30 | NRSM Short Courses and Workshop – Morning Session |
| | "Hands On Phased Array Beamforming Workshop" |
| 13:00 – 16:00 | NRSM Short Courses and Workshop – Afternoon Session |
| | "Successful Proposal Writing for Sustainable and Impactful Research – from tenure-track through the long game" |
| | "Reconfigurable Intelligent Surfaces for Communications and Radars" |
| 17:00 – 21:00 | USNC-URSI Business Meeting - Invitation Only |

WEDNESDAY, 10 January

| | |
|---|---|
| 08:15 – 17:00 | Vendor Booths |
| 08:20 – 10:00 | Technical Sessions |
| 10:00 – 10:20 | Break (with coffee, hot tea, water) |
| 10:20 – 12:00 | Technical Sessions |
| 12:10 – 13:10 | Women in Radio Science (WIRS) Business Meeting |
| 13:20 – 14:20 | Student Paper Competition (SPC) |
| 14:20 – 14:40 | Break (with coffee, hot tea, sparkling water, sodas, water) |
| 14:40 – 16:20 | Technical Sessions |
| 16:20 – 17:20 | Commission Business Meetings (B, C&E, D, F) |
| 17:20 – 18:20 | Commission Business Meetings (A, G, J) |
| 18:30 – 21:00 | 50th Anniversary Banquet & SPC Awards |

## THURSDAY, 11 January

| | |
|---|---|
| 08:20 – 11:15 | 50th Anniversary Plenary Session |
| | 08:20 – 08:30 Introductions |
| | 08:30 – 08:45 Commission A |
| | 08:45 – 09:00 Commission B |
| | 09:00 – 09:15 Commission C |
| | 09:15 – 09:30 Commission D |
| | 09:30 – 09:45 Commission E |
| | 09:45 – 10:00 Commission F |
| | 10:00 – 10:15 Coffee Break |
| | 10:15 – 10:30 Commission G |
| | 10:30 – 10:45 Commission H |
| | 10:45 – 11:00 Commission J |
| | 11:00 – 11:15 Commission K |
| 11:30 – 13:15 | Student Mentoring Luncheon (Lunch provided for all students, commission chairs, and USNC-URSI Officers) |
| 13:30 – 17:30 | Vendor Booths |
| 13:30 – 15:10 | Technical Sessions |
| 15:10 – 15:30 | Break (with coffee, hot tea, sparkling water, sodas, water) |
| 15:30 – 17:30 | Technical Sessions |
| 17:30 – 18:30 | Commission Business Meetings (H, K) |
| 19:00 – 20:30 | WIRS Reception (Ticket Required, Contact WIRS Leadership) |

## FRIDAY, 12 January

| | |
|---|---|
| 06:30 – 08:10 | USNC–URSI Executive Council Meeting – Invitation Only |
| 08:15 – 17:00 | Vendor Booths |
| 08:20 – 10:00 | Technical Sessions |
| 10:00 – 10:20 | Break (with coffee, hot tea, water) |
| 10:20 – 12:00 | Technical Sessions |
| 12:10 – 13:00 | Eleventh Hans Liebe Lecture |
| 13:10 – 15:10 | Technical Sessions |
| 15:10 – 15:30 | Break (with coffee, hot tea, sparkling water, sodas, water) |
| 15:30 – 17:30 | Technical Sessions |

# 2024 USNC-URSI National Radio Science Meeting

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Tuesday, 9 January | 08:30–11:30 | **Workshop**<br>**"Hands On Phase Array Beamforming Workshop" (Room DLC1B70)** | | | | | | | |
| | 13:00–16:00 | **Workshop and Short Course**<br>**"Successful Proposal Writing for Sustainable and Impactful Research — From Tenure-Track Through the Long Game" (Room 1B40)**<br>**"Reconfigurable Intelligent Surfaces for Communications and Radars" (Room 150)** | | | | | | | |
| **Time [MST] \ Room** | | **105** | **150** | **151** | **155** | **200** | **245** | **265** | **1B40** |
| Wednesday, 10 January | 08:20–12:00 | | K1: EM Applications in Biomedical Diagnosis, Imaging and Sensing | BF1*: Topics in Radio Science: In Memory of W. Ross Stone | GH1*: Meteors, Orbital Debris and Dusty Plasmas | D1: Cryogenic RF Circuits<br>G2: Ionospheric Radio and Propagation | F1: Point-to-Point Propagation Effects | J2: New Telescopes, Techniques, and Technologies & Observatory Reports I<br>J2: New Telescopes, Techniques, and Technologies & Observatory Reports II | B2: Antenna, Theory, and Design I |
| | 12:10–13:10 | **Women in Radio Science (WIRS) Business Meeting (Math 100)** | | | | | | | |
| | 13:20–14:20 | **Student Paper Competition (Math 100)** | | | | | | | |
| | 14:40–16:20 | | E1: Electromagnetic Environment and Interference | B3*: Progress in Reconfigurable Intelligent Surfaces (RIS) | H1*: Ionospheric Modification | D2*: RF Front-ends and Arrays for Simultaneous Transmit and Receive Operation | F2: Random and Complex Media Models in Remote Sensing | J3: New Telescopes, Techniques, and Technologies & Observatory Reports III | B4: Antenna, Theory, and Design II |
| | 16:20–17:20 | | Commission C&E | | | Commission D | Commission F | | Commission B |
| | 17:20–18:20 | Commission A | | | Commission G | | | Commission J | |
| | 18:30–21:00 | **50th Anniversary Banquet & SPC Awards (Embassy Suites)** | | | | | | | |

| Time [MST] \ Room | | 105 | 150 | 151 | 155 | 200 | 245 | 265 | 1B40 |
|---|---|---|---|---|---|---|---|---|---|
| Thursday, 11 January | 08:20–11:15 | 50th Anniversary Plenary Session (Math 100) | | | | | | | |
| | 11:30–13:15 | Student Mentoring Luncheon (KOBL S100 - Lunch provided for all students, USNC-URSI Officers, and Commission Chairs) | | | | | | | |
| | 13:30–17:30 | C1: Adaptive RADAR and Array Signal Processing Techniques | BK5*: Advances in Wireless Power Transfer and Harvesting for Biomedical Communication and Applications | B6: Propagation, Scattering, and Sensing I | H2*: Active Experiments in Laboratory and Space Plasmas<br>H3*: Physics of the Radiation Belts: Coupling of Different Plasma Populations by Means of Plasma Waves | D3*: Hyperspectral Sensing for Space Applications<br>G3*: Beacon Satellite Science and Applications: In Memory of Patricia Doherty | FGH3*: Remote Sensing Using GNSS-R and SoOp Systems | J3*: RFI Mitigation and Spectrum Management I<br>J4*: ngVLA Antenna Development | BF7*: Quantum Technology Applications in Electromagnetics and Remote Sensing |
| | 17:30–18:30 | | Commission K | | Commission H | | | | |
| | 19:00–20:30 | WIRS Reception (Embassy Suites) | | | | | | | |
| Time [MST] \ Room | | 105 | 150 | 151 | 155 | 200 | 245 | 265 | 1B40 |
| Friday, 12 January | 06:15–08:00 | USNC–URSI Executive Council Meeting – Invitation Only [Room TBD] | | | | | | | |
| | 08:20–12:00 | A1*: Clutter, Noise, Troposcatter Measurements and Models<br>A2: Advances in Antenna Design | E2: History and Future of USNC Commission E | B8: Propagation, Scattering, and Sensing II<br>B10*: Antennas for Planetary Exploration | H4: Waves and Interactions in Plasmas | D4: Wide bandgap Semiconductors & Radar Applications | F4*: Rough Surface Scattering and Electromagnetics: In Honor of Gary Brown | J5*: RFI Mitigation and Spectrum Management II | B9*: Multifunctional Antennas and Arrays for Satellite and Wireless Communications |
| | 12:10–13:00 | Eleventh Hans Liebe Lecture (Math 100) | | | | | | | |
| | 13:10–17:30 | A3: Advances in Electromagnetic Measurements: Antennas and Beyond | C2: Advances in Software Defined and Adaptive Radio Systems | B11: Theory, Materials, and Devices<br>B12: Numerical Methods | H5*: Heliospheric Observations of Waves in Plasmas<br>H6: Heliospheric Plasma Processes | GH4*: Machine Learning Techniques for Near Earth Space Science<br>G5: Radar and Radio Techniques for Ionospheric Diagnostics | F5*: Microwave Remote Sensing of the Earth | J6*: CHIME/FRB Outriggers I<br>J7*: CHIME/FRB Outriggers II | D5*: Recent Advances in Reconfigurable Intelligent Surfaces<br>B13*: Complex EM and Meta Structures |

* Denotes a special session

## International Union of Radio Science / Union Radio-Scientifique Internationale

Founded in 1919, the International Union of Radio Science (URSI) coordinates studies, research, applications, scientific exchange, and communication in all fields of radio science from telecommunications and radio astronomy to medicine. For further information on URSI, please visit www.ursi.org.

Both URSI and the U.S. National Committee (USNC) for URSI are organized into ten commissions:

Electromagnetic Metrology (Commission A)
Fields and Waves (Commission B)
Radiocommunication Systems and Signal Processing (Commission C)
Electronics and Photonics (Commission D)
Electromagnetic Environment and Interference (Commission E)
Wave Propagation and Remote Sensing (Commission F)
Ionospheric Radio and Propagation (Commission G)
Waves in Plasmas (Commission H)
Radio Astronomy (Commission J)
Electromagnetics in Biology and Medicine (Commission K)

## About the USNC–URSI

The U.S. National Committee for URSI (USNC–URSI) is appointed by the National Academies of Sciences, Engineering, and Medicine, and represents U.S. radio scientists in URSI. It encourages studies in radio science, provides a forum for the dissemination of research findings, and provides an organizational infrastructure for the radio science community in the United States. Individuals may become members of one or more USNC-URSI Commissions through nominations by an existing Commission member and vote by the Commission members. For more information about USNC-URSI membership, including requirements for Full, Associate and Early Career membership levels, please visit www.usnc-ursi-archive.org/membership or contact the appropriate Commission Chair(s) listed below.

The USNC–URSI hosts the National Radio Science Meeting (NRSM) each January in Boulder, Colorado. This meeting is technically co–sponsored by the Antennas and Propagation Society of the Institute of Electrical and Electronics Engineers (IEEE/AP–S). The IEEE International Symposium on Antennas and Propagation and USNC–URSI Radio Science Meeting (RSM), co–sponsored by the IEEE/AP–S and USNC–URSI, is held each summer. Every five to eight years, a North American Radio Science Meeting (NARSM) is organized, co–sponsored by the U.S. and Canadian National Committees for URSI. The last NARSM was held virtually in Montreal, Quebec, Canada on 4–11 July 2020; the next NARSM is planned for August 2025 in Ottawa, Canada.

The international URSI General Assembly and Scientific Symposium (GASS) is held every three years in locations around the world. The 35th URSI GASS was held in Sapporo, Hokkaido, Japan, on 19 – 26 August 2023. There were over 1400 attendees from 49 countries, and over 1400 papers were presented in technical sessions covering the areas of all ten URSI Commissions. The 36th URSI GASS will be held in Krakow, Poland, on 15–22 August 2026.

In addition to the GASS, URSI holds two other flagship meetings every three years, the Atlantic Radio Science Conference (AT–RASC) and the Asia–Pacific Radio Science Conference (AP–RASC). Please visit www.ursi.org for more information on these URSI conferences.

*For further information on USNC–URSI please visit www.usnc-ursi-archive.org.*

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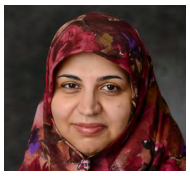

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**USNC–URSI would like to thank the following Special Session Organizers:**

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## Platinum ($5000)

JOHNS HOPKINS
APPLIED PHYSICS LABORATORY

## WIRS Reception

# Invited Speakers

## 50th Anniversary Plenary Speaker — Commission A

*USNC-URSI Commission A – History and Mission*

**Steve Weiss**
Johns Hopkins University

**Abstract:** This Plenary Presentation will discuss both the history and mission of Commission A. The discussion will include historical background as well as the evolution of the topics addressed by the Commission.

In general, the mission of Commission A is to promote research and development in the field of measurement standards and physical constants, calibration and measurement methodologies, improved quantification of uncertainty, continued achievement of accuracy and traceability of measurements. Areas of emphasis pertain to Electromagnetic measurements and standards.

Accordingly, the Commission specifically addresses: (a) Measurements and standards in time and frequency, including infrared and optical frequencies; (b) Measurements in the time domain; (c) Measurements in the frequency domain; (d) Measurements in telecommunications; (e) Measurements using lasers; (f) Quantum metrology and electrical methods in fundamental constants; (g) Measurements and standards from dc to optical frequencies.

As such, the commission fosters accurate and consistent measurements needed to support research, development, and exploitation of electromagnetic technologies across the spectrum and for all commissions.

Additionally, the presentation will discuss the relationship between the USNC-URSI and URSI as well as the association with the IEEE APS conference.

**Biographical Sketch:** Dr. Steven Weiss obtained his bachelor's degree in Electrical Engineering from the Rochester Institute of Technology in 1985 (BSEE) and graduate degrees from George Washington University in 1989 (MS) and 1995 (DSc), both with concentrations in Electrophysics.

Dr. Weiss worked with the Army Research Lab from 1988 until retirement in 2023. As he was the team leader for the Antenna Team, he was instrumental in the development of numerous specialized antennas for military applications. The work ranged from antennas for communications in the VHF band, radar antennas, and antennas for Satellite on the Move (SOTM,) as well as antennas for collision avoidance. His interests included the associated beamformers and beamforming networks.

He is a fellow of the Washington Academy of Science and is on the board of directors of the Applied Computational Electromagnetics Society (ACES). He is a Senior Member of IEEE and has served in all officer positions for the Washington Section of the IEEE. He is a member of URSI Commissions A and B and served as the vice-chair and chair of Commission A. Additionally, he is an international member of URSI.

Dr. Weiss has taught at Johns Hopkins University since 2002 teaching courses in Antenna Systems, Advanced Antenna Systems, and Intermediate Electromagnetics. He has published numerous papers in the IEEE Antennas and Propagation society's transactions, letters, and conferences. He is a registered professional engineer in the states of Maryland and Delaware and maintains an active status in both states.

## 50th Anniversary Plenary Speaker — Commission B

*Contributions and Accomplishments of USNC-URSI Commission B*

**Branislav M. Notaros**
Colorado State University, Fort Collins, CO

**Abstract:** The 2024 National Radio Science Meeting (NRSM) to be held from January 9-13, 2024 at the University of Colorado at Boulder is the 50th Anniversary Event of NRSMs Boulder. Namely, at the 2024 NRSM, we will be celebrating the 50th anniversary of holding this meeting in Boulder, Colorado. This talk presents contributions of the Commission B of the U.S. National Committee (USNC) for the International Union of Radio Science (URSI) to the very

rich 50-year history and legacy of USNC-URSI and NRSM achievements with discussions of the present activities and an outlook for the future.

USNC-URSI Commission B covers all technical and scientific aspects of Fields and Waves. Commission B topics for NRSM Boulder meetings are clustered around Antennas; Propagation, Scattering, and Sensing; Numerical Methods of Electromagnetics; Electromagnetic Theory, Materials, and Education; and Devices, Systems, and Applications. We have organized, in every year, a great number of NRSM Special Sessions on established and emerging theories, techniques, technologies, and applications of Fields and Waves, with prominent invited authors and speakers within Commission B as well as leaders of interdisciplinary research and practice within the radio science community. USNC-URSI Commission B has also been a very active participant in our joint summer meetings with the IEEE Antennas and Propagation Society (AP-S), IEEE International Symposia on Antennas and Propagation and USNC-URSI Radio Science Meetings – APS/URSI Joint Meetings.

The talk outlines USNC-URSI Commission B achievements and activities within half of a century, both technical/scientific and professional, in a celebratory spirit, but also addresses an outlook for the future of the commission and the organization, as well as encountered or anticipated challenges of the present time and the future. It emphasizes the accomplishments directly related to NRSM Boulder Meetings but also discusses the activities of the commission overall including APS/URSI Joint Meetings and our technical and professional activities outside of the meetings and conferences. The overview is greatly facilitated by the USNC-URSI Radio Science Meeting Archive, which includes copies of most of the proceedings of the National Radio Science Meetings in Boulder and USNC-URSI Radio Science Meetings, held jointly with IEEE AP-S, spanning the period from 1963 to the present, as well as other useful information.

**Biographical Sketch:** Branislav M. Notaros is a Professor of Electrical and Computer Engineering, Director of Electromagnetics Laboratory, and University Distinguished Teaching Scholar at Colorado State University. Previously, he held assistant/associate-professor positions at the University of Massachusetts Dartmouth and University of Belgrade. His research contributions are in computational and applied electromagnetics. His publications include more than 300 journal and conference papers, and textbooks "Electromagnetics" (2010) and "MATLAB-Based Electromagnetics" (2013) with Pearson Prentice Hall and "Conceptual Electromagnetics" (2017) with CRC Press.

Prof. Notaroš serves as President Elect of the IEEE Antennas and Propagation Society (AP-S), Chair of the USNC-URSI Commission B, Immediate Past President of the Applied Computational Electromagnetics Society (ACES), and Track Editor of the IEEE Transactions on Antennas and Propagation. He served as General Chair of the IEEE APS/URSI 2022 Denver Conference, Chair of the IEEE AP-S Meetings Committee, Chair of the Joint Meetings Committee, and AP-S AdCom member. He was the recipient of the 1999 IEE Marconi Premium, 2005 IEEE MTT-S Microwave Prize, 2022 IEEE Antennas and Propagation Edward E. Altshuler Prize Paper Award, 2019 ACES Technical Achievement Award, 2014 Carnegie Foundation Colorado Professor of the Year Award, 2015 ASEE ECE Distinguished Educator Award, 2015 IEEE Undergraduate Teaching Award, and many other research and teaching awards. He is Fellow of IEEE and ACES.

## 50th Anniversary Plenary Speaker — Commission C

*The Future of Signals and Systems*

**Dev Palmer**
DARPA Microsystems Technology Office

**Abstract:** The information- and intelligence-based economy continues to drive an explosion of data that must be moved, stored, processed, communicated, and converted to end-user information. This phenomenon raises an important question: Can the current trends in communications signals and systems keep up? Breakthroughs are needed in a wide range of key technologies. Among those critical capabilities are the development of new materials and device structures that maximize performance and efficiency, as well as new algorithms and hardware for signal processing that can handle the speed, scale, and complexity of the modern electromagnetic spectrum environment.

This talk will cover some of the national-level challenges facing communications signals and systems, highlight recent government programs addressing these challenges, and discuss relevant research results at DARPA.

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**Biographical Sketch:** Dev Palmer is Managing Director, Next-Generation Microelectronics Manufacturing at the DARPA Microsystems Technology Office. Previously he served as MTO Deputy Director. Prior to joining DARPA, he was Chief Technologist at Lockheed Martin Advanced Technology Laboratories where he directed the independent research and development program and implemented technology strategy. Earlier in his career he directed a portfolio of programs ranging from basic research to advanced technology transition in Program Manager roles at DARPA and the Army Research Office. Dr. Palmer is a Life Fellow of the IEEE, author on over 100 publications in print and electronic media, and inventor on four US patents.

## 50th Anniversary Plenary Speaker — Commission D

*A History of Technical Contributions*

**Jonathan D. Chisum† and Zoya Popovic‡**
†The University of Notre Dame, Notre Dame, IN
‡University of Colorado at Boulder, Boulder, CO

**Abstract:** Commission D: Electronics and Photonics, promotes research and reviews new development in: (a) Electronic devices and applications; (b) Photonic devices and applications; (c) Physics, materials, CAD, technology and reliability of electronic and photonic devices, with particular reference to radio science and telecommunications. The Commission deals with devices for generation, detection, storage and processing of electromagnetic signals together with their applications, covering all frequencies, including those in the microwave and optical domains.

In this talk we will review the community of and technical contributions from Commission D throughout the decades. Major thrusts include the maturation of electronic and photonic devices in Si/SiGe and III-V devices for signal generation and processing, metamaterial and plasmonic structures and optical fiber for the guiding of signals, and system applications including wireless and imaging for commercial and defense, THz and millimeter-wave instrumentation for security and planetary and earth sciences, and reconfigurable RF for cognitive radios in spectrum sensing/sharing. In addition, metrology and computer automated design tools will be discussed as supporting the major device, component, and system themes.

**Biographical Sketch:** Jonathan Chisum received the Ph.D. in Electrical Engineering from the University of Colorado at Boulder in Boulder, Colorado USA, in 2011. From 2012 to 2015 he was a Member of Technical Staff at the Massachusetts Institute of Technology Lincoln Laboratory in the Wideband Communications and Spectrum Operations groups. His work at Lincoln Laboratory focused on millimeter-wave phased arrays, antennas, and transceiver design for electronic warfare applications. In 2015 he joined the faculty of the University of Notre Dame where he is currently as Associate Professor in the Department of Electrical Engineering. He is the current and immediate past chair for USNC-URSI Commission D. His research interests include millimeter-wave communications and spectrum sensing using novel and engineered materials and devices to dramatically lower the power and cost and enable pervasive deployments. His group focuses on gradient index (GRIN) lenses for low-power millimeter-wave beam-steering antennas, nonlinear low-energy radio architectures for highly efficient communications and sensing up through millimeter-waves, phase-change materials for reconfigurable RF circuits for wideband distributed circuits and antennas, and microwave/spin-wave structures for low-power and chip-scale analog signal processing for spectrum sensing and protection.

**Biographical Sketch:** Distinguished Professor Zoya Popovic received the Dipl.Ing. degree from the University of Belgrade, Serbia, Yugoslavia, in 1985, and the PhD degree from the California Institute of Technology, Pasadena, in 1990. Since 1990, she has been with the University of Colorado Boulder, where she is currently a Distinguished Professor and holds the Lockheed Martin Endowed Chair in RF Engineering in the Department of Electrical, Computer and Energy Engineering. In

2001, she was a visiting professor with the Technical University of Munich, Munich, Germany. Since 1991, she has graduated more than 50 PhD students. She has served as the past USNC-URSI Commission D Chair and she is the current Chair of the USNC-URSI Women in Radio Science Chapter. Her research interests include high-efficiency, low-noise, and broadband microwave and millimeter-wave circuits, quasi-optical millimeter-wave techniques for imaging, smart and multibeam antenna arrays, intelligent RF front ends, and wireless powering for batteryless sensors. Popovic was the recipient of the 1993 and 2006 Microwave Prizes presented by the IEEE Microwave Theory and Techniques Society (IEEE MTT-S) for the best journal papers, and received the 1996 URSI IssacKoga Gold Medal. In 1997, Eta Kappa Nu students chose her as a Professor of the Year. She was the recipient of a 2000 Humboldt Research Award for Senior U.S. Scientists from the German Alexander von Humboldt Stiftung. She was elected a Foreign Member of the Serbian Academy of Sciences and Arts in 2006. She was also the recipient of the 2001 Hewlett-Packard(HP)/ American Society for Engineering Education(ASEE) Terman Medal for combined teaching and research excellence.

## 50th Anniversary Plenary Speaker — Commission E

*Some Highlights in Commission E in National Radio Science Meetings*

**Robert L. Gardner**
Consultant, Marietta, GA

**Abstract:** This Commission emphasizes (1) the scientific theory and engineering aspects of effects associated with naturally occurring and artificially induced electromagnetic-interference phenomena and (2) electromagnetic compatibility theory and practice for applications. Its activities provide venues for exchanging theoretical and technological knowledge and economic considerations for achieving electromagnetic spectral harmony. In particular, research presented in Commission E meetings has included:

1. Radiofrequency spectrum management
2. Scientific basis and effects of natural and intentional emissions on system performance
3. Electromagnetic compatibility in computational electromagnetics, education, measurement technologies, standards and radiation hazards
4. Electromagnetic modeling of systems and environments
5. High-power electromagnetic effects of transients on electronic systems

There has been a large variation in numbers and in topics over the last 50 years of Boulder meetings. Particular leaders, and, sometimes, lack of leadership have driven those changes. About 35 of the conference proceedings were available to us showing the rising and falling of topics like Electromagnetic Pulse and Spectrum Management.

I can only tell the early part of the story from my point of view, but the Commission E documentation begins when I started attending USNC Boulder meetings in 1978. I started working for Dr. J. R. Wait on my PhD in 1978 and gave my first talk at NRSM that same year. Dr. David LeVine gave a talk on fields radiated from lightning in the combined session, which became central to my thesis work and the later high – power electromagnetics sessions. The HPE sessions continued until the BE joint session in 2021.

Dr. George Hagn was USNC Commission E chair in 1978. He was one of three of us that continued to become international Commission E Chairs. R. L. Gardner and D. V. Giri were the other two. While HPE was an important part of Commission E's work, primarily due to the encouragement of Dr. Carl Baum, noise characterization and frequency management were also central to that work for decades under such leaders as Dr. R. D. Parlow, G. Hagn, and Anthony Fraser – Smith.

**Biographical Sketch:** Dr. Robert L. Gardner received his PhD in Physics from the University of Colorado in Boulder in 1980 under the direction of Dr. A. V. Phelps and Dr. J. R. Wait. He began his association with the National Radio Science Meeting in 1978 and continued a 15-year

Commission E leadership role starting with USNC Commission E Vice-Chair in 1990, E Chair in 1993, International E Vice Chair in 1996, International E Chair in 1999 and Member at Large for USNC in 2002.

Dr. Gardner has served in a variety of technical positions as military officer, civil servant, contractor and consultant for the Air Force, Navy, and Under Secretary of Defense for Intelligence. He has won a number of awards including a Legion of Merit, 3 Best Paper Awards and several technical society fellowships. He is now a Principal Research Engineer for the Georgia Tech Research Institute.

Dr. Gardner received his PhD in Physics from the University of Colorado in Boulder in 1980 under the direction of Dr. A. V. Phelps and Dr. J. R. Wait. He began his association with the National Radio Science Meeting in 1978 and continued a 15-year Commission E leadership role starting with USNC Commission E Vice-Chair in 1990, E Chair in 1993, International E Vice Chair in 1996, International E Chair in 1999 and Member at Large for USNC in 2002.

Dr. Gardner has served in a variety of technical positions as military officer, civil servant, contractor and consultant for the Air Force, Navy, and Under Secretary of Defense for Intelligence. He has won a number of awards including a Legion of Merit, 3 Best Paper Awards and several technical society fellowships. He is now a Principal Research Engineer for the Georgia Tech Research Institute.

## 50th Anniversary Plenary Speaker — Commission F

### *50 Years of Wave Propagation and Remote Sensing Science at the National Radio Science Meeting in Boulder, CO*

**David Kunkee[†], Thomas Hanley[‡], Christopher Ruf[§], and Mehmet Ogut[*]**

[†]The Aerospace Corporation, Los Angeles, CA; [‡]JHU-APL, Baltimore, MD; [§]University of Michigan, Ann Arbor, MI; [*]JPL, Pasadena, CA

**Abstract:** In 2024 we celebrate the 50th anniversary of the National Radio Science Meeting (NRSM) in Boulder, CO. The roots of Commission F can be traced back to the earlier commissions of the national committee, specifically Commission II involving 'Radio and Non-Ionized Media.' The change to Commission F was part of a reorganization of USNC-URSI that occurred shortly after the meeting series began in Boulder in 1974. This was the beginning of present-day Commission F involving Wave Propagation and Remote Sensing.

Since 1978 the Commission F series of presentations at the Boulder NRSM has offered many opportunities for inquiry on important topics in radio science including atmospheric attenuation and ducting, propagation in complex media, Earth surface modelling, and application of new sensors and technology. Recently, modern approaches to remote sensing involving CubeSats and signals of opportunity, for example, are treated while leveraging the wealth of knowledge held by the Commission members and their close ties related to the various radio science disciplines represented within the USNC. One topic that has been featured routinely in Commission F sessions at Boulder involves the detailed characteristics of wave propagation through the Earth's atmosphere. The Hans Liebe Lecture Series has been held at the NRSM since 2014 to honor his contributions in this area.

This talk will commemorate 50 years of wave propagation and remote sensing science within the U.S. radio science community at the NRSM Boulder meetings. It will summarize the history and growth of Commission F membership and its scope while suggesting important topics for future inquiry by its members. Accordingly, some topics to consider for the future include the advancement of Radio Frequency Interference (RFI) detection and techniques to control its negative impact on observations of the Earth, modeling and measurement of millimeter-wave propagation in support of 5G and 6G networks, remote sensing of planets that may have sub-surface oceans, technology and techniques for the next generation of scientific instruments supporting remote sensing as well as other emerging topics.

**Biographical Sketch:** David Kunkee received the Ph.D. degree in electrical engineering from the Georgia Institute of Technology, Atlanta, in 1995. He joined The Aerospace Corporation in 1995 and is currently a Principal Engineer/Scientist within the Sensor Systems Subdivision. From 2010 to 2014 he was a member of the Environmental Satellite Systems Division as part of the Defense Weather Satellite System (DWSS) and Weather System Follow-on (WSF) program offices. From 2006 to 2010 he was a member of the National Polar-orbiting Operational Environmental Satellite

System (NPOESS) Integrated Program Office (IPO), and led the Aerospace Microwave Sensors and Data Products Department within the NPOESS IPO. From 2002 to 2005 he was the Associate Director of the Radar and Signal Systems Department at Aerospace. Dr. Kunkee has served on several review boards supporting space-based sensors and technology for environmental monitoring and associated mission development.

Dr. Kunkee is currently Vice-Chair of USNC-URSI Commission F and Past-President of the IEEE Geoscience and Remote Sensing Society (GRSS). He was General Co-Chair of the 2017 International Geoscience and Remote Sensing Symposium (IGARSS) and served as Co-Chair of the Technical Program Committee for IGARSS 2010 and 2023. From 2007 to 2009 he was Editor-in-Chief of the GRSS Newsletter. Dr. Kunkee has also served on the U.S. National Academies' Committee on Radio Frequencies (CORF) including its Committee on Scientific Use of the Radio Spectrum.

## 50th Anniversary Plenary Speaker — Commission G

*Progress in Understanding Our Ionosphere, Atmosphere, and Near-Earth Space through URSI Commission G: Selected 50 Year Highlights*

**Philip J. Erickson**
MIT Haystack Observatory

**Abstract:** URSI Commission G - ionospheric radio and propagation - focuses on ionospheric communications and remote sensing of ionized media. The Commission deals with the study of Earth's ionosphere in both a basic and applied sense, in order to provide a broad understanding necessary for radio communications along with the physics, chemistry, and electrodynamics of ionized media in near-Earth space. Particular focus areas include (a) Global morphology and modeling of the ionosphere; (b) Ionospheric space-time variations; (c) Development of tools and networks needed to measure ionospheric properties and trends; (d) Theory and practice of radio propagation via the ionosphere; and (e) Application of ionospheric information to radio communications. To achieve these objectives, Commission G works closely with other URSI Commissions, corresponding bodies of the ICSU family (e.g. IUGG, IAU, COSPAR, SCOSTEP) and other relevant organizations (e.g. ITU, IEEE).

The history of US Commission G parallels the origins and history of URSI itself, as the earliest 20th century remote sensing tools for the charged upper atmosphere were radio wave based, occurring well before the advent of spacecraft direct sampling of these regions. We briefly review the 50 year history of Commission G in this light, with its participants and studies driving many significant firsts in global radio science. These include (1) continued innovations in HF ionosondes, considered the oldest active ionospheric remote sensing technique; (2) the extremely powerful collective Thomson/incoherent scatter radar technique for providing full altitude profiles of the thermal ionospheric plasma state; (3) the incisive development of global ionospheric total electron content observations and science using global navigation satellite signal (GNSS) scientific receivers and processing; (4) in conjunction with Commission H, active plasma experiments investigating fundamental physics using HF transmissions from ionospheric heaters; (5) ionospheric modeling advances and coupling to whole-atmosphere frontier models, including the important development of the IRI empirical ionospheric model; and (6) multi-wavelength radio scintillation investigations of ionospheric plasma irregularities and deep electron density depletions. Throughout, we will highlight common themes in these advances based on technology advances in radio wave capture, combined with increasing sophistication in first-principles understanding of ionospheric physics and space weather dynamics.

**Biographical Sketch:** Dr. Philip J. Erickson is a Principal Research Scientist and the director of Haystack Observatory, a multidisciplinary radio and radar remote sensing observatory operated by Massachusetts Institute of Technology for studies of near-Earth space, Earth dynamics, and the radio universe. He has been a Haystack scientist for 29 years and has led the observatory's Atmospheric and Geospace Sciences group since 2015 in its active and passive radio remote sensing programs, using a variety of techniques and RF signals at femtowatt to megawatt levels. Erickson is the principal investigator for the NSF funded Millstone Hill Geospace Facility, which encompasses the large aperture mid-latitude Millstone Hill UHF incoherent scatter radar system, global GNSS total electron content observations, and the Madrigal distributed database. He is also the principal investigator for a forthcoming NASA Heliophysics dual small satellite mission to study Earth's radio aurora in low Earth orbit using MF and HF frequency electromagnetic vector sensors. Erickson's research focuses on linear and nonlinear dynamics of Earth's ionosphere,

thermosphere, plasmasphere, and radiation belts, along with collective Thomson and fundamental plasma irregularity scattering mechanisms.

His association with URSI Commission G began in graduate school at Cornell University, where he received a PhD in space plasma physics in 1998 under the direction of radio remote sensing pioneers and Commission G members Donald Farley, Michael Kelley, and Wesley Swartz. Erickson is an associate editor for Frontiers in Astronomy and Space Science, advises on the board of the HamSCI citizen science initiative, and serves on a number of committees including the National Academy of Science, Engineering, and Mathematics (NASEM) Committee on Radio Frequencies. He is co-chair of the NASEM Panel on the Physics of Ionospheres, Thermospheres, and Mesospheres within the 2024-2033 Decadal Survey for Solar and Space Physics (Heliophysics).

## 50th Anniversary Plenary Speaker — Commission H

*Waves in Plasmas: A 50-Year Quest for Resonance through Inhomogeneities, Anisotropies, and Induced Perturbations*

**Mark Golkowski**
University of Colorado – Denver

**Abstract:** The past half-century has marked an era of remarkable achievement for USNC URSI Commission H. The primary focus of the commission members is the study of waves in plasmas in the broadest sense. As such our membership has tackled a vast spectrum of plasma physics and radio waves, encompassing scales ranging from the intricate orbits of individual electrons to the profound planetary ramifications of space weather. Major activities can be categorized into active geophysical experiments, observations on the ground and with spacecraft, laboratory plasma experiments, and theoretical and simulation efforts.

Commission H's enduring legacy is underscored by the creation of iconic ground facilities, including the legendary Arecibo Observatory, Siple Station, and the groundbreaking HAARP facility. These facilities have empowered us with the extraordinary ability to actively probe and manipulate natural plasmas using high-power radio waves. Taking advantage and studying nature's own powerful radio waves from thunderstorm lightning has also bestowed upon us a trove of knowledge.

Attempts to reproduce the complex physics of space-based wave-particle interactions continue to be pursued, chiefly at the Naval Research Laboratory and also at the University of California Los Angeles. Large plasma chambers with multi-meter dimensions and intense magnetic fields are used to recreate the space plasma environment and replicate nonlinear interactions and wave mode conversions. Numerous scientific orbital spacecraft were launched in the past decades that provided fresh insight into radio wave interactions with space plasmas. Worth highlighting are missions both young and old starting with the NASA Orbiting Geophysical Observatory (OGO) in the 1960's and the more recent missions of the Van Allen Probes (2012-2019), Magnetospheric Multiscale Mission (launched 2015) and the US Air Force DSX satellite (2019-2021).

The extraordinary increase in available computing power over the last three decades has touched all research fields and in Commission H at least two areas of focus are worth mentioning. The complex and three dimensional nature of wave-plasma interactions makes self-consistent simulation very computationally expensive. One powerful technique is the so-called particle-in-cell (PIC) algorithm in which individual charged particle trajectories are tracked under the influence of all electromagnetic forces. In the last 15 years a number of PIC and hybrid-PIC codes have been developed to reproduce key wave-particle interactions. Another area of focus has been leveraging machine learning algorithms for space weather prediction. Work in this area has accelerated and the coming years will no doubt bring new capabilities.

As we celebrate five decades of discovery, Commission H stands at the precipice of a bright future, poised to unlock new dimensions of plasma wave phenomena.

**Biographical Sketch:** Mark Golkowski received his B.S. degree in electrical engineering from Cornell University in 2002 and his M.S. and Ph.D. degrees in electrical engineering from Stanford University in 2004 and 2009, respectively. He served as a Postdoctoral Fellow with the Space, Telecommunications, and Radio Science Laboratory at Stanford University from 2009-2010. His doctoral work and subsequent research heavily utilized the HAARP facility in Gakona, Alaska for

experiments on active ELF/VLF wave injection into space. Dr. Golkowski is currently Professor and Chair of Electrical Engineering at the University of Colorado Denver. He actively conducts research on electromagnetic waves in plasmas, ionospheric physics, near-Earth space physics, and biomedical applications of gas discharge plasmas. Dr. Golkowski has served as associate editor of the journal Earth, Moon, Planets. Dr. Golkowski was recipient of International Association of Geomagnetism and Aeronomy (IAGA) Young Scientist Award for Excellence in 2008, IEEE Electromagnetic Compatibility Society Best Symposium Paper Award in 2011 and National Science Foundation CAREER Award in 2013. He served as Associate Dean of Education and Student Success in 2020-2022 and has received campus level recognition in teaching, research, and student mentoring at the University of Colorado Denver. Dr. Golkowski served as Chair of USNC Commission H Waves in Plasmas from 2020-2023.

## 50th Anniversary Plenary Speaker — Commission J

*Discovering the Radio Universe*

**Ken I. Kellermann[1] and Alyson Ford[2]**

[1]National Radio Astronomy Observatory, Charlottesvile, VA

[2]Steward Observatory, University of Arizona

**Abstract:** Until Karl Jansky's 1933 discovery of non-thermal cosmic radio emission at Bell Laboratories, astronomy was limited to observations in the narrow visible slice of the electromagnetic spectrum. Jansky and later Grote Reber opened the radio window to studying the Universe. Using instruments of ever increasing sensitivity and resolution, radio astronomers discovered bursts of radio noise from the Sun, electrical storms on Jupiter, radio galaxies, quasars, apparent faster-than-light motion, the cosmic microwave background, the first observational evidence for the big-bang and cosmic evolution, pulsars, gravitational lensing, cosmic masers, giant molecular clouds, evidence for dark matter, fast radio bursts, and the first known planets beyond our Solar System.

Most of these radio astronomy discoveries were serendipitous: they were unanticipated and unexpected, often involving some degree of luck. Theory generally played no role, or, in some cases, even led in the wrong direction and delayed discoveries which might have otherwise occurred earlier. Some discoveries came as a result of military activities, others from industrial research, some from academic research intended for other purposes, and some from even just looking with a new instrument or new technique. Often it was the right person in the right place doing the right thing – or sometimes the wrong thing. The scientists responsible for these discoveries were mostly young - under 40 years of age, and had little or no formal training in astronomy. Although there is no Nobel Prize in astronomy, the first three Nobel Prizes awarded for work in observational astronomy went to six radio astronomers.

Following a surge in the rate of new discoveries by radio astronomers in the decades following World War II, since the 1980s the rate of discovery has declined. Similarly, following the initial awards of Nobel Prizes to six radio astronomers, for the past thirty years there have been no new discoveries in radio astronomy that have led to a Nobel Prize. We conclude with speculations about why the rate of new discoveries has decreased and how the changing culture of scientific research may constrain the rate of future new discoveries.

The National Radio Astronomy Observatory is a facility of the National Science Foundation operated under cooperative agreement by Associated Universities Inc.

**Biographical Sketch:** Ken Kellermann is a Senior Scientist Emeritus at the National Radio Astronomy Observatory where he works on the study of radio galaxies, quasars and cosmology, on the development of new instrumentation for radio astronomy, and on the history of radio astronomy. He is a Member of the National Academy of Sciences, a Foreign Member of the Russian Academy of Sciences, the German Max Planck Society and a Fellow of American Philosophical Society. He has received the Warner Prize of the American Astronomical Society, the Gould Prize of the National Academy of Sciences, the 2014 Bruce Medal of the Astronomical Society of the Pacific, and was co-recipient the 1971 Rumford Medal of the American Academy of Arts and Sciences for his role in the development of VLBI. He has

served as the Chairs of the USNC-URSI (CJ) and USNC-IAU as well as the President of IAU Commission 40 (Radio Astronomy).

**Biographical Sketch:** Dr. Alyson Ford is the Associate Director of Steward Observatory at the University of Arizona, where she oversees the Arizona Radio Observatory (ARO) and Mountain Operations (Mtn Ops) groups. These groups are responsible for the maintenance, operations, and development projects of Steward Observatory's radio, optical, and infrared facilities located on Kitt Peak, Mount Lemmon, Mount Bigelow, and Mt. Graham. Dr. Ford's research focuses primarily on the gaseous content of galaxies and the processes that shape this gas, with an emphasis on extremely faint emissions that can only be detected using Earth's most sensitive radio telescopes. With a strong interest in operations, instrumentation, and image and signal processing, she also applies her expertise to space domain awareness (SDA) activities. Dr. Ford served as Lead Scientist for the RadioAstron Green Bank Earth Station, and has led several proof-of-concept tests for satellite tracking in MEO and GEO belts, performed bistatic radar observations of near-Earth asteroids, infrared observations of high area-to-mass ratio (HAMR) objects, space debris, and satellites, and is particularly interested in passive radar. She is a member of the Event Horizon Telescope Collaboration and currently serves as Chair of Commission J (Radio Astronomy) for the United States National Committee (USNC) for the Union Radio-Scientifique Internationale (URSI). Dr. Ford received her PhD in Astrophysics from Swinburne University of Technology in Melbourne, Australia.

## 50th Anniversary Plenary Speaker — Commission K

*The Intersection of Radio Science and Biology and Medicine:*

*A Celebration of the Past and Future of Commission K*

Susan C. Hagness
University of Wisconsin – Madison, Madison, WI

**Abstract:** Radio scientists and electromagnetic engineers have long been inspired by the prospects of contributing to the advancement of human health and quality of life. Commission K sessions at the National Radio Science Meeting (NRSM) have provided an invaluable venue for disseminating research advances at the intersection of radio science with biology and medicine. At the foundation of Commission K is a focus on the physical interaction mechanisms of electromagnetic fields and waves – from DC to daylight – with biological systems, whether at the cellular or whole human body level. Two primary pillars build upon that foundation: 1) basic research on biological effects, the underlying mechanisms responsible for the effects, and techniques for quantifying and assessing exposure to electromagnetic fields and waves, and 2) applied research involving the development of diagnostic and therapeutic technologies for a host of medical applications. Commission K has also embraced research on communications and sensing technologies for non-medical applications that nevertheless involve interactions with the human body.

As we celebrate the 50th anniversary of the NRSM in Boulder, CO, it is exciting to reflect on a 50-year span that straddles both the past and the future. Accordingly, this talk will provide a brief 25-year retrospective, highlighting representative research advances across the foundation and pillars of Commission K, and a forward-looking vision for the next 25 years. A timely societal challenge for Commission K to tackle is healthy aging. There are currently more than 55 million people in the U.S. above age 65, according to U.S. census data from 2020, and by 2030 an estimated 1.4 billion people will be over 60 years of age, according to the World Health Organization. Electromagnetics engineering in biology and medicine includes countless research directions that will yield future technologies in support of healthy aging, including supporting aging in place (e.g. health status monitoring and screening, detecting falls, etc.), energy harvesting for powering smartphones and other devices for monitoring and rehabilitation, and advancing point-of-care diagnostics and novel therapies.

**Biographical Sketch:** Susan C. Hagness received the B.S. and Ph.D. degrees in electrical engineering from Northwestern University in 1993 and 1998, respectively. She is currently the Philip D. Reed Professor of the Department of Electrical and Computer Engineering at the University of Wisconsin-Madison, where she has served as Department Chair since 2018. She previously served as the College of Engineering Associate Dean for Research (2014-2017) and has held

a variety of professional society and advisory board appointments and leadership roles within the IEEE, the U.S. National Committee of URSI, the ASEE Engineering Research Council, and ECEDHA. She has co-authored more than 100 journal papers, eight book chapters, and two editions (with Allen Taflove) of Computational Electrodynamics: The Finite-Difference Time-Domain Method (Artech House, 2000 and 2005).

She has received numerous recognitions for her holistic approach to teaching and mentoring and for her research in computational and experimental applied electromagnetics, which has emphasized medical applications over the past 25 years. Highlights include the Presidential Early Career Award for Scientists and Engineers (2000), the IEEE Engineering in Medicine and Biology Society Early Career Achievement Award (2004), the URSI Issac Koga Gold Medal (2005), the IEEE Trans. Biomedical Engineering Outstanding Paper Award (2007), the IEEE Education Society Van Valkenburg Early Career Teaching Award (2007), the Physics in Medicine and Biology Citations Prize (2011), the UW-Madison Women Faculty Mentoring Program Slesinger Award for Excellence in Mentoring (2017), and College of Engineering awards for excellence in teaching (2014), research (2018), and equity and diversity efforts (2021). She is a Fellow of the IEEE (2009), AAAS (2021), AIMBE (2022), and NAI (2022).

## Eleventh Liebe Lecture

*Ground-Based Microwave Radiometers:*

*Missing Puzzle Pieces in Laying the Picture of the Atmospheric State*

**Ulrich Löhnert**
University of Cologne, Germany

**Abstract:** Currently, there is a world-wide observation gap of wind, temperature, and humidity profiles in the Atmospheric Boundary Layer (ABL), particularly as operational numerical models are approaching the km to sub-km scale. Ground-based passive microwave radiometers (MWR) can simultaneously deliver information on atmospheric humidity and temperature profiles, as well as on the column integrated liquid water path. As opposed to other remote sensing methods, MWRs can profile continuously throughout the entire troposphere, even in the case of optically thick water clouds. State-of-the-art MWR operate robustly 24/7 during all-weather conditions, are commercially available (and affordable) and are consequently being implemented in different observational networks worldwide. However, their vertical resolution is limited, especially above the atmospheric boundary layer, constraining the information content of the measurements.

This lecture will review stand-alone performance of state-of-the-art MWR and give a status report on their implementation within current observational networks. A major focus will be on how MWR can be used complementary with other (remote) sensors to fill the existing observational gap in the ABL. This includes the synergy with standard meteorological observations, collocated ground-based remote sensors such as lidar, radar or infrared spectrometer, as well as different current and future satellite sensors (e.g. geostationary infrared sounders). Existing and future network configurations of MWR will be presented and what benefits these provide for applications such as nowcasting of atmospheric stability and short-term weather forecasting. Also, the potential of using elevation and azimuth scanning MWR configurations for measurement quality control as well as for detecting horizontal atmospheric inhomogeneities will be discussed.

**Biographical Sketch:** Prof. Ulrich Löhnert is professor for Meteorology at the University of Cologne, and since 2020 leads the research group Exploiting Observations in Meteorology. Before becoming an extraordinary professor in 2020, he co-led the research group on Integrated Ground-based Remote Sensing since 2007. In 2012 he obtained his habilitation in Meteorology from the University of Cologne following a time as assistant professor at the Meteorological Institute, Ludwig-Maximilians-University Munich (2004–2006). His main research interest lies in using ground-based remote sensing for enhanced atmospheric process understanding and improving numerical models. He has been coordinator of German research network projects funded by the German Ministry for Research and Education (BMBF) and has acted as PI in numerous nationally funded projects (German Research Foundation, DFG and BMBF). He has established strong research with the German Weather Service (DWD) and since 2020, he is PI within the ACTRIS-D initiative, which is part of the ACTRIS ERIC (European Infrastructure Consortium). He is currently co-chair of the WMO

WWRP working group on Data Assimilation and Observation Systems (DAOS) and has also been working group leader and management committee member of several EU-funded COST actions. His research also benefits from long lasting collaborations with US-researchers in active and passive atmospheric remote sensing.

## Short Course, Tutorials and Workshop

*Workshop*

*Hands On Phased Array Beamforming Workshop*

Jon Kraft, Analog Devices
Laila Fighera, University of Colorado – Boulder

Phased array communications and radar systems are finding increased use in a variety of applications. This places a greater importance on training engineers and rapidly prototyping new phased array concepts. However, this has historically been difficult and expensive. But a recent open source offering, the CN-0566 Phaser, allows real beamforming hardware to be used for education, project proposals, and product development. This workshop will introduce that offering with lectures and hands on labs covering: phased array beamforming (steering angle and beam formation), antenna impairments (side lobes/tapering, grating lobes, beam squint), monopulse tracking implementation, and jammer mitigation through null steering. Each of these topics will be addressed with a short lecture, followed by the participants using the Phaser hardware to directly explore the lecture topic.

**Biographical Sketch:** Jon Kraft joined Analog Devices in 2007, after spending 9 years at Motorola/ON Semiconductor. He is now a principal field applications engineer with a focus in software-defined radio and phased array radar. He posts examples of these concepts, using simple hardware and software, at www.youtube.com/@jonkraft. He is also the architect, and perpetual explorer, of the CN0566 Software Defined Phased Array Radar project, commonly called the "Phaser." He received a B.S.E.E. from Rose-Hulman, a M.S.E.E. from Arizona State University, and has 10 patents issued.

**Biographical Sketch:** Laila Fighera Marzall received her B.S. degree in electrical engineering from the Federal University of Santa Maria in 2006; her M.S. in electrical engineering from Aeronautics Institute of Technology, ITA, in 2009, in Brazil, and her Ph.D. degree in electrical engineering from the University of Colorado Boulder in 2022. She works as a Postdoctoral Associate at the University of Colorado Boulder Microwave Group. Her research is focused on broadband phased arrays and non-reciprocal devices, like circulators and phase shifters, as well as MMIC power amplifiers. She is a Senior Member of the IEEE and a URSI Associate Member.

*Workshop*

*Successful Proposal Writing for Sustainable and Impactful Research* – From Tenure-Track Through the Long-Game

Jonathan Chisum, University of Notre Dame
Chris Anderson, United State Naval Academy

Whether you are a graduate student or a post-doc seeking your first faculty appointment, a tenure-track assistant professor working to establish a research group, or a full professor looking to increase your impact, successful proposal writing is an essential skill. Unfortunately, proposal writing is often learned by immersion or, when taught, is treated in such a general manner that it lacks relevance. This tutorial panel will provide concrete examples of both funded and unfunded proposals to share the "do's and don'ts" of proposal writing. The panel comprises researchers at various stages in their career, spanning a variety of disciplines, with experience in academia, government labs, and non-profits. They will provide concrete suggestions that are immediately useful for attendees. The discussion will present a systematic approach to proposal writing that can not only lead to a sustainable flow of funding, but will also help generate original ideas, refine research plans, establish vibrant collaborations, and make an impact. Our panelists will discuss: the funding landscape including NSF, DoD, industry, non-profit, and international organizations; how to pursue small, medium, and large research programs; how to contact program managers, how to construct white papers and survive a visit (or virtual meeting) to DC; the key elements of a proposal and how to make your proposal irresistible (a

"must fund" proposal); telling a compelling and complete story (leaving no major doubts); developing a cadence for proposal writing, execution, and paper writing; and more. Example of successful proposals will be presented.

**Biographical Sketch:** Jonathan D. Chisum received the Ph.D. in Electrical Engineering from the University of Colorado at Boulder in Boulder, Colorado USA, in 2011. He is currently an Associate Professor of Electrical Engineering at the University of Notre Dame. From 2012 to 2015 he was a Member of Technical Staff at the Massachusetts Institute of Technology Lincoln Laboratory in the Wideband Communications and Spectrum Operations groups. His work at Lincoln Laboratory focused on millimeter-wave phased arrays, antennas, and transceiver design for electronic warfare applications. In 2015 he joined the faculty of the University of Notre Dame. His research interests include millimeter-wave communications and spectrum sensing using novel and engineered materials and devices to dramatically lower the power and cost and enable pervasive deployments. His group focuses on gradient index (GRIN) lenses for low-power millimeter-wave beam-steering antennas, nonlinear (1-bit) radio architectures for highly efficient communications and sensing up through millimeter-waves, phase-change materials for reconfigurable RF circuits for wideband distributed circuits and antennas, and microwave/spin-wave structures for low-power and chip-scale analog signal processing for spectrum sensing and protection. Dr. Chisum is a senior member of the IEEE, a member of the American Physical Society, and an elected Member of the U.S. National Committee (USNC) of the International Union or Radio Science's (URSI) Commission D (electronics and photonics). He is the current Chair for USNC URSI Commission D: Electronics and Photonics. He is also an Associate Editor for IET Electronics Letters.

**Biographical Sketch:** Christopher R. Anderson joined the National Telecommunications and Information Administration (NTIA) Institute for Telecommunication Sciences (ITS) in 2023 following a distinguished 16-year tenure at the United States Naval Academy (USNA) as an Associate Professor in the Electrical Engineering Department. At USNA, he founded and directed the Wireless Measurements Group, a specialized research team focusing on spectrum, propagation, and field strength measurements in diverse environments and frequencies ranging from 300 MHz to 28 GHz. During 2016-2018, Dr. Anderson served as a Visiting Researcher for the NTIA ITS Theory Division, concentrating on the development of propagation models for cluttered environments. Currently, his primary interests lie in enhancing spectrum coexistence between active and passive technologies and improving wireless coverage in rural or under-served areas. Dr. Anderson is a former Editor of the IEEE Transactions on Wireless Communications, the Chair of the UAV and V2V Channel Modeling Subgroup of the IEEE P.1944 Mobile Communication Network Standards Committee, and the Chair of the URSI US National Committee Commission A Electromagnetic Metrology.

*Short Course*

*Reconfigurable Intelligent Surfaces for Communications and Radars*

Kumar Vijay Mishra, United States DEVCOM Army Research Laboratory

In recent years, reconfigurable intelligent surfaces (RISs) have shown promising abilities to control and manipulate electromagnetic (EM) waves through modified surface boundary conditions. These surfaces are electrically thin and comprise an array of spatially varying sub-wavelength scattering elements (or meta-atoms). Through careful engineering of each meta-atom, RISs can transform an incident EM wave into an arbitrarily tailored transmitted or reflected wavefront. Recent developments in RISs have opened exciting new opportunities in antenna design, as well as communications and radar systems. RISs - wherein meta-atoms are embedded with active components - lead to the development of low-cost, lightweight, and compact systems that can produce programmable radiation patterns, jointly perform multi-function communications, and enable advanced radars for next-generation military platforms. This short course will introduce RISs and their various applications in designing simplified communications and radar systems, wherein the RF aperture and transceiver are integrated within the RIS. For example, dynamic reconfiguration of the RIS aperture in a wireless communications transmitter facilitates beam steering, frequency agility, and phase modulation without conventional front-end devices such as phase-shifters, mixers, and switches. We will present our recent work on reconfigurable RIS control, RIS-enabled direct signal modulation, and deep learning-based RIS design. Finally,

we will present deploying RIS as a reflector in the wireless channel for aiding non-line-of-sight radar and joint radar-communications.

**Biographical Sketch:** Kumar Vijay Mishra (S'08-M'15-SM'18) obtained a Ph.D. in electrical engineering and M.S. in mathematics from The University of Iowa in 2015, and M.S. in electrical engineering from Colorado State University in 2012, while working on NASA's Global Precipitation Mission Ground Validation (GPM-GV) weather radars. He received his B. Tech. summa cum laude (Gold Medal, Honors) in electronics and communication engineering from the National Institute of Technology, Hamirpur (NITH), India in 2003. He is currently Senior Fellow at the United States Army Research Laboratory (ARL), Adelphi; Technical Adviser to Singapore-based automotive radar start-up Hertzwell and Boston-based imaging radar startup Aura Intelligent Systems; and honorary Research Fellow at SnT - Interdisciplinary Centre for Security, Reliability and Trust, University of Luxembourg. Previously, he had research appointments at Electronics and Radar Development Establishment (LRDE), Defence Research and Development Organisation (DRDO) Bengaluru; IIHR - Hydroscience & Engineering, Iowa City, IA; Mitsubishi Electric Research Labs, Cambridge, MA; Qualcomm, San Jose; and Technion - Israel Institute of Technology.

Dr. Mishra is the Distinguished Lecturer of the IEEE Communications Society (2023-2024), IEEE Aerospace and Electronic Systems Society (AESS) (2023-2024), IEEE Vehicular Technology Society (2023-2024), and IEEE Future Networks Initiative (2022). He is the recipient of the IET Premium Best Paper Prize (2021), U. S. National Academies Harry Diamond Distinguished Fellowship (2018-2021), American Geophysical Union Editors' Citation for Excellence (2019), Royal Meteorological Society Quarterly Journal Editor's Prize (2017), Viterbi Postdoctoral Fellowship (2015, 2016), Lady Davis Postdoctoral Fellowship (2017), DRDO LRDE Scientist of the Year Award (2006), NITH Director's Gold Medal (2003), and NITH Best Student Award (2003). He has received Best Paper Awards at IEEE MLSP 2019 and IEEE ACES Symposium 2019.

Dr. Mishra is Chair (2023-present) of the Synthetic Apertures Technical Working Group of the IEEE Signal Processing Society (SPS) and Vice-Chair (2021-present) of the IEEE Synthetic Aperture Standards Committee, which is the first SPS standards committee. He is the Vice Chair (2021-2023) and Chair-designate (2023-2026) of the International Union of Radio Science (URSI) Commission C. He has been an elected member of three technical committees of IEEE SPS: SPCOM, SAM, and ASPS, and IEEE AESS Radar Systems Panel. Since 2020, he has been Associate Editor of IEEE Transactions on Aerospace and Electronic Systems, where he was awarded Outstanding Editor recognition in 2021. He has been a lead/guest editor of several special issues in journals such as IEEE Signal Processing Magazine, IEEE Journal of Selected Topics in Signal Processing, and IEEE Journal on Selected Areas in Communications. He is the lead co-editor of three upcoming books on radar: Signal Processing for Joint Radar-Communications (Wiley-IEEE Press), Next-Generation Cognitive Radar Systems (IET Press Radar, Electromagnetics & Signal Processing Technologies Series), and Advances in Weather Radar Volumes 1, 2 & 3 (IET Press Radar, Electromagnetics & Signal Processing Technologies Series). His research interests include radar systems, signal processing, remote sensing, and electromagnetics.

# Student Luncheon

**Moderator: Charles Bayliss, Baylor University**

Panelists:

Timothy Palagi is a Radio Remote Sensing Architect and Associate Fellow at Lockheed Martin Space.

Branislav M. Notaros is a Professor of Electrical and Computer Engineering, Director of Electromagnetics Laboratory, and University Distinguished Teaching Scholar at Colorado State University. Previously, he held assistant/associate-professor positions at the University of Massachusetts Dartmouth and University of Belgrade. His research contributions are in computational and applied electromagnetics. His publications include more than 300 journal and conference papers, and textbooks "Electromagnetics" (2010) and "MATLAB-Based Electromagnetics" (2013) with Pearson Prentice Hall and "Conceptual Electromagnetics" (2017) with CRC Press.

Prof. Notaroš serves as President Elect of the IEEE Antennas and Propagation Society (AP-S), Chair of the USNC-URSI Commission B, Immediate Past President of the Applied Computational Electromagnetics Society (ACES), and Track Editor of the IEEE Transactions on Antennas and Propagation. He served as General Chair of the IEEE APS/URSI 2022 Denver Conference, Chair of the IEEE AP-S Meetings Committee, Chair of the Joint Meetings Committee, and AP-S AdCom member. He was the recipient of the 1999 IEE Marconi Premium, 2005 IEEE MTT-S Microwave Prize, 2022 IEEE Antennas and Propagation Edward E. Altshuler Prize Paper Award, 2019 ACES Technical Achievement Award, 2014 Carnegie Foundation Colorado Professor of the Year Award, 2015 ASEE ECE Distinguished Educator Award, 2015 IEEE Undergraduate Teaching Award, and many other research and teaching awards. He is Fellow of IEEE and ACES.

Jeanne T. Quimby received a B.S. degree from the University of California of San Diego in 1998 and her M. S.in 2001 and Ph.D. in 2005 from The Ohio State University. In 2006, she joined the Space and Naval Warfare Systems Center Pacific (now known as the NIWC-Pacific) as a communication expert and researcher. Since 2015, she has been working at the National Institute of Standards and Technology (NIST) in the Communication Technology Laboratory (CTL). Her current research focuses on a NextG infrastructure cybersecurity strategy composed of non-invasive radio access network measurements at the physical layer (L1) together with the data link layer (L2) and network layer (L3). Her strategy detects anomalous behavior by comparing suspect behavior to a stable behavior using cybersecurity analytics. The methodology, tools, and curated datasets are applicable to a wide range of NextG telecommunication infrastructures from NextG Radio Access Networks to Internet-of-Thing (IoT); enables standards (e.g. 3GPP) compliance testing. She has also launched enhanced channel sounder verification through the formation of the IEEE standard 2982 working group. She was the recipient of the Department of Commerce Bronze award in 2019 for recognition for developing innovative measurement methods, a state-of-the-art testbed, and extensive first-in-class measurement data sets that led to a comprehensive Guide to Industrial Wireless Systems Deployments. She is the current Women in Radio Science (WIRS) vice chair chapter for the United States National Committee for Union Radio Scientifique Internationale (USNC URSI).

Tuesday, January 9 08:30 - 11:30
Event Room DLC1B70

## Hands On Phased Array Beamforming Workshop

Tuesday, January 9 13:00 - 16:00
Event Room 1B40

## Successful Proposal Writing for Sustainable, and Impactful Research – from tenure-track through the long game

Tuesday, January 9 13:00 - 16:00
Event Room 150

## Reconfigurable Intelligent Surfaces for Communications and Radars

Tuesday, January 9 17:00 - 21:00
Event

## USNC-URSI Business Meeting – Invitation Only

Wednesday, January 10 08:20 - 12:00
K1 Room 150

## EM Applications in Biomedical Diagnosis, Imaging and Sensing

Session Co-Chairs: Sima Noghanian, CommScope Ruckus Wireless Networks; Hakki Gurhan, University of Colorado Boulder

**K1.1** **08:20**
Comparison of Different Microwave Tissue Phantoms for the Design of an Optimal Validation System for RF Devices
*Anthony Giordano, Melany Hernandez, Satheesh Venkatakrishnan, Florida International University, United States*

**K1.2** **08:40**
Electromagnetic Uncertainty Analysis of 3D Biological Phantoms
*Apoorva Pedgaonkar, UNIVERSITY OF UTAH, United States; Gregory Moss, Remcom Inc., United States; Jamesina Simpson, UNIVERSITY OF UTAH, United States*

**K1.3** **09:00**
Estimating the spatial average of breast tissue permittivity using single- and multiple-channel transmission measurements for patient-specific microwave hyperthermia beamformer design
*Tessa A. Haldes, Susan C. Hagness, University of Wisconsin-Madison, United States*

**K1.4** **09:20**
Internal Body Temperature Measurements Using a Miniaturized Hybrid Radiometer
*Jooeun Lee, Sofia Mvokany, Zoya Popovic, University of Colorado Boulder, United States*

**K1.5** **09:40**
The Influence of Low-Intensity Radiofrequency Fields on Superoxide Dismutase Activity in Cancer Cells
*Hakki Gurhan, Frank Barnes, University of Colorado Boulder, United States*

**Break** **10:00**

**K1.6** **10:20**
Comparison of the RF Fields Distribution Between a High-Permittivity Material and a Metasurface for Magnetic Resonance Imaging
*Sabrina Rotundo, University of Pisa, Italy; Giuseppe Carluccio, New York University, United States; Danilo Brizi, University of Pisa, Italy; Christopher Collins, New York University, United States; Agostino Monorchio, University of Pisa, Italy; Riccardo Lattanzi, New York University, United States*

**K1.7** **10:40**
Low-Frequency Magnetic Field and Cancer Cells
*Marek Bajtoš, University of Zilina, Slovakia; Nhat Dang, Hakki Gurhan, Frank Barnes, University of Colorado Boulder, United States*

**K1.8** **11:00**
Evaluating the MR Safety of Passive Implants in Surgical and After Heal Models at 1.5 T and 3 T MRI
*Ananya Nandikanti, Jianfeng Zheng, Ji Chen, University of Houston, United States*

**K1.9** **11:20**
Propagation of a the Fields from a Single Coil in a High-Permittivity Helmet for MRI Applications
*Giuseppe Carluccio, Christopher Collins, New York University, United States*

**K1.10** **11:40**
The Use of RF and Magnetic Fields for Communication and Control Between and Within Cells: "A Cell Phone System for Cells"
*Frank Barnes, Hakki Gurhan, University of Colorado Boulder, United States*

Wednesday, January 10 08:20 - 12:00
BF1 Special Session Room 151

## Topics in Radio Science: In Memory of W. Ross Stone

Session Co-Chairs: George Uslenghi, University of Chicago; Michael Newkirk, Johns Hopkins University Applied Physics Lab

**BF1.1** **08:20**
A Tribute to the Legacy of Ross Stone: From Hertz Cylindrical Reflector Antenna to Novel Remote Sensing Antennas
*Yahya Rahmat-Samii, University of California at Los Angeles (UCLA), United States*

**BF1.2** **08:40**
A Survey of Progress in the Numerical Evaluation of Singular and Near-Singular Integrals
*Donald Wilton, University of Houston, United States; Francesca Vipiana, Politecnico di Torino, Italy; William Johnson, Electromagnetics Consultant, United States*

**BF1.3** **09:00**
Enhancement of Temporal Sampling for Global Remote Sensing of Water Vapor Profiles, Clouds and Precipitation: Recent Results from the Temporal Experiment for Storms and Tropical Systems (TEMPEST) Missions
*Steven C. Reising, Christian D. Kummerow, V. Chandrasekar, Chandrasekar Radhakrishnan, Chia-Pang Kuo, Colorado State University, United States; Shannon T. Brown, Todd C. Gaier, Sharmila Padmanabhan, NASA/Caltech Jet Propulsion Laboratory, United States; Richard Schulte, Colorado State University, United States*

**BF1.4** **09:20**
Optimization of Fabry–Perot Cavity Antennas having Horizontal or Vertical Dipole Sources
*Walter Fuscaldo, Consiglio Nazionale delle Ricerche, Italy; David Jackson, University of Houston, United States; Alessandro Galli, Sapienza University of Rome, Italy*

**BF1.5** **09:40**
Some Unusual Methodologies and Unconventional Applications in Electromagnetics and Radio Science: In Memory of W. Ross Stone
*Branislav Notaros, Colorado State University, United States*

**Break** **10:00**

**BF1.6** **10:20**
A PARABOLIC METAMATERIAL LENS FOR MATCHING BETWEEN PARALLEL-PLATE WAVEGUIDES
*Piergiorgio L. E. Uslenghi, University of Illinois at Chicago, United States*

**BF1.7** **10:40**
Attenuation of the Average Norton Surface Wave Propagating Along a Gently Undulating Surface
*Gary Brown, Virginia Tech, United States*

**BF1.8** **11:00**
Printed Flexible/Wearable Antennas for 5G Applications: A Review
*Sembiam Rengarajan, California State University, United States; Taimoor Khan, National Institute of Technology, Silchar, India*

**BF1.9** **11:20**
Trends and Approaches for Improving Self-Interference Cancellation of Radios Across a Wide Bandwidth
*John Volakis, Satheesh Venkatakrishnan, Florida International University, United States*

**BF1.10** **11:40**
A Pathway to Service
*Michael Newkirk, Johns Hopkins University Applied Physics Lab, United States*

Wednesday, January 10 08:20 - 12:00
GH1 Special Session Room 155

## Meteors, Orbital Debris and Dusty Plasmas

Session Co-Chairs: Sigrid Eischot; Alex Fletcher

**GH1.1** **08:20**
Using Numerical Solutions of the Forced Korteweg-de Vries Equation and Particle-In-Cell Simulations to Study Solitons in Space Plasmas
*Ashwyn Sam, Nicolas Lee, Sigrid Elschot, Stanford University, United States*

**GH1.2** **08:40**
Satellite and Space Debris Identification by Measurements of Ionospheric Interactions
*Paul Bernhardt, University of Alaska Fairbanks, United States; Lauchie Scott, DRDC Ottawa Research Centre, Canada; Andrew Howarth, University of Calgary, Canada; George Morales, University of California Los Angeles, United States; Jeff Baumgardner, Boston Universityu, United States*

**GH1.3** **09:00**
Experimental Investigation of Orbital Debris Soliton Generation
*Bill Amatucci, Erik Tejero, Ami DuBois, Lon Enloe, Dave Blackwell, Chris Crabtree, Guru Ganguli, Naval Research Laboratory, United States; Abhijit Sen, Institute for Plasma Research, India*

**GH1.4** **09:20**
Electrostatic and Electromagnetic Orbital Debris Generated Solitons: Theory and Analysis Techniques
*Chris Crabtree, Guru Ganguli, Alex Fletcher, Rualdo Soto-chavez, US Naval Research Laboratory, United States; Abhijit Sen, Institute for Plasma Research, India*

**GH1.5** **09:40**
Simulations of Nonlinear Plasma Structures Generated by Orbital Debris and Dust
*Alex Fletcher, Chris Crabtree, Gurudas Ganguli, Rualdo Soto-Chavez, Naval Research Laboratory, United States*

**Break** **10:00**

**GH1.6** **10:20**
Evolution of Soliton Structures from Interaction with Radar Waves
*Michael Kwara, Nicolas Lee, Sigrid Elschot, Stanford University, United States*

**GH1.7** **10:40**
Meteor Head Echo Detection via a Convolutional Neural Network Trained on Synthetic Radar Data
*Trevor Hedges, Nicolas Lee, Sigrid Elschot, Stanford University, United States*

**GH1.8** **11:00**
Meteor Radar Phase Interferometry Calibration with Aircraft Observations and ADS-B Integration
*John Marino, Nicholas Rainville, James Monaco, Scott Palo, University of Colorado Boulder, United States; Ryan Volz, Massachusetts Institute of Technology, United States*

**GH1.9** **11:20**
Ionization of Hypervelocity Impact Iron Plasmas via a Monte Carlo Collision Model
*Dennis Dong, Raymond Lau, Nicolas Lee, Sigrid Elschot, Stanford Univesity, United States*

**GH1.10** **11:40**
Plasma Sensor for Detecting Meteoroid Impacts on the Moon
*Xiaohan Mei, Raymond Lau, Nancy Diallo, Dennis Dong, Michael Kwara, Nicolas Lee, Sigrid Elschot, Stanford, United States*

Wednesday, January 10 08:20 - 10:00
D1 Special Session Room 200

## Cryogenic RF circuits

Session Co-Chairs: Akim Babenko, Jet Propulsion Laboratory; Leonardo Ranzani, Raytheon BBN

**D1.1** **08:20**
Superconducting Integrated Filters for Kinetic-Inductance Traveling-Wave Parametric Amplifiers
*Akim Babenko, Peter Day, Pekka Kangaslahti, Jet Propulsion Laboratory, United States*

**D1.2** **08:40**
Towards ultralow-noise cryogenic InP high electron mobility transistors: investigation of physical origins of microwave noise
*Bekari Gabritchidze, Kieran Cleary, Austin Minnich, Caltech, United States*

**D1.3** **09:00**
Superconducting Kinetic Inductance-Based On-Chip Frequency Conversion
*Grant Giesbrecht, University of Colorado Boulder, United States; Nathan Flowers-Jacobs, Adam Sirois, Michael Vissers, Manuel Castellanos-Beltran, National Institute of Standards and Technology, United States; Taylor Barton, University of Colorado Boulder, United States; Paul Dresselhaus, National Institute of Standards and Technology, United States*

**D1.4** **09:20**
Characterization of High-Power Superconducting Microwave Resonators
*Daniil Frolov, IBM, United States; Alexander Netepenko, Sergey Kotelnikov, Fermilab, United States*

**D1.5** **09:40**
VHF Josephson Arbitrary Waveform Synthesizer
*Jeremy Thomas, Nathan Flowers-Jacobs, Anna Fox, National Institute of Standards and Technology, United States; Akim Babenko, University of Colorado, United States; Samuel Benz, Paul Dresselhaus, National Institute of Standards and Technology, United States*

Wednesday, January 10 08:20 - 12:00
F1 Room 245

## Point-to-Point Propagation Effects

Session Co-Chairs: Katherine Mulreany, Naval Postgraduate School; Jonathan Gehman, Johns Hopkins University Applied Physics Laboratory

**F1.1** **08:20**
Effects of Mismatch Between Digital Elevation Models and Numerical Weather Prediction Terrain Heights on Propagation Modeling
*Abby Anderson, NRLDC, United States*

**F1.2** **08:40**
Grid Optimization of Mixed Environments for RF Propagation.
*Rick Navarro, NIWC Pacific - US Navy, United States*

**F1.3** **09:00**
The Sensitivity of RF Propagation to Stable Atmospheric Surface Layer Properties
*Katherine Mulreany, Qing Wang, Naval Postgraduate School, United States*

**F1.4** **09:20**
Radar and Electromagnetic Ducting in Stable Atmosphere over Water (REDSAW)
*Qing Wang, Katherine Mulreany, Ryan Yamaguchi, Jesus Ruiz-Plancarte, David Ortiz-Suslow, Naval Postgraduate School, United States; Caglar Yardim, The Ohio State University, United States; Victor Wiss, Naval Surface Warfare Center - Dahlgren Division, United States; Ted Rogers, Scripps Institute of Oceanography, United States; Matthew Wilbanks, Naval Surface Warfare Center - Dahlgren Division, United States; David Flagg, Qingfang Jiang, U.S. Naval Research Laboratory, United States*

**F1.5** **09:40**
Influence of Evaporation Duct Lateral Inhomogeneity on X-band Propagation
*Daniel P. Greenway, Douglas M. Pastore, Alexis E. Vaughan, Erin E. Hackett, Coastal Carolina University, United States*

**Break** **10:00**

**F1.6** **10:20**
Phase Error Analysis for Sensing Evaporation Duct Heights
*Kessen Barrett, Ted Rogers, Peter Gerstoft, University of California San Diego, United States*

**F1.7** **10:40**
Phased Array Refractivity Estimation in Coastal Ducting Environment
*Joe Vinci, Caglar Yardim, Elizabeth Shi, The Ohio State University, United States*

**F1.8** **11:00**
Validation of ERA5 Reanalysis Refractivity Characterizations
*Paul Frederickson, Naval Postgraduate School, United States*

**F1.9** **11:20**
Speedy Assessment of Meteorological Equivalence for RF Propagation
*Zach Beever, Jonathan Gehman, Johns Hopkins University Applied Physics Laboratory, United States; Jordan McCammon, Elliot Shiben, Naval Surface Warfare Center Dahlgren Division, United States*

**F1.10** **11:40**
Evaluation of COAMPS driven electromagnetic propagation modeling using field campaign measurements
*Sarah Wessinger, Naval Research Laboratory, United States; Qing Wang, Naval Postgraduate School, United States; Hedley Hansen, Defense Science and Technology Group, Adelaide, Australia, Australia; Tony De Paolo, Peter Rogowski, Scripps Institution of Oceanography, United States; Andrew Kammerer, Naval Research Laboratory, United States*

Wednesday, January 10 08:20 - 10:00
J2 Room 265

## New Telescopes, Techniques, and Technologies & Observatory Reports I

Session Co-Chairs: Alyson Ford, University of Arizona; Steven Ellingson, Virginia Tech

**J2.1** **08:20**
Nearfield to Farfield Methods for Drone Beam Mapping
*Will Tyndall, Yale University, United States*

**J2.2** **08:40**
EM Simulation of the Effects of Mechanical Perturbations to the HIRAX Telescope
*Kit Gerodias, McGill University, Canada*

**J2.3** **09:00**
SAFARI - A differential approach to probe the cosmological sky-averaged 21-cm signal
*Bang Nhan, Richard Bradley, National Radio Astronomy Observatory, United States*

**J2.4** **09:20**
Holographic Beam Mapping for the Canadian Hydrogen Intensity Mapping Experiment
*Alex Reda, Yale University, United States*

**J2.5** **09:40**
Exploring the Crosstalk properties of the CHIME Telescope
*Pranav Sanghavi, Laura Newburgh, Yale University, United States*

Wednesday, January 10 08:20 - 12:00
B2 Room 1B40

## Antenna, Theory, and Design I

Session Co-Chairs: Nader Behdad, University of Wisconsin-Madison; Danilo Erricolo, University of Illinois Chicago

**B2.1** **08:20**
Millimeter wave dual-band antenna array on a thin flexible substrate for 5G applications
*Saeid Alamdar, Sahar Bagherkhani, Franco De Flaviis, University of California, Irvine, United States; Soheil Saadat, Multi-Fineline Electronix Inc, United States*

**B2.2** **08:40**
Singular Metric for Antenna Array Mutual Coupling: Unveiling the Array Coupling Index (ACI)
*Majid Manteghi, Virginia Tech, United States*

**B2.3** **09:00**
Deployable 18:1 Tightly Coupled Aperture with Integrated UWB Feed Network
*Jorge A. Caripidis Troccola, Satheesh B. Venkatakrishnan, John L. Volakis, Florida International University, United States*

**B2.4** **09:20**
In-Situ Calibration of Active Electronically Scanned Antenna Arrays Through SAR Imaging
*Duncan Madden, Kamal Sarabandi, University of Michigan, United States*

**B2.5** **09:40**
A Novel Shaped Symmetric Wideband Dielectric Resonator Antenna by Binary Material Optimization
*Trupti Bellundagi, Binbin Yang, North Carolina A&T University, United States*

**Break** **10:00**

**B2.6** **10:20**
An Electronically-Reconfigurable Matching and Decoupling Network for a Two-Element HF Antenna Array
*Arman Afsari, Barry Van Veen, Nader Behdad, University of Wisconsin-Madison, United States*

**B2.7** **10:40**
GPR Spiral Antenna Transient Response based on Target RCS
*David Rohde, Ryan Adams, University of North Dakota, United States*

**B2.8** **11:00**
Overcoming the Chu Limit Using Switched-Mode, Non-LTI, Electrically-Small Transmitting Antennas
*Marisa Liben, Mirhamed Mirmozafari, Daniel Ludois, Nader Behdad, University of Wisconsion-Madison, United States*

**B2.9** **11:20**
Obstacle Imaging Through Orthogonal Coded Phased Array Antennas
*Alan Salari, University of Illinois Chicago, United States; Gianluca Gennarelli, INSTITUTE FOR ELECTROMAGNETIC SENSING OF THE ENVIRONMENT, NATIONAL RESEARCH COUNCIL OF ITALY, Italy; Francesco Soldovieri, Institute for Electromagnetic Sensing of the Environment, National Research Council of Italy, Italy; Danilo Erricolo, University of Illinois Chicago, United States*

**B2.10** **11:40**
Toward Large-Scale, High Sensitivity Terahertz Focal Plane Arrays
*Russell Raldiris Torres, Ebrahim Al Seragi, Saeed Zeinolabedinzadeh, Georgios Trichopoulos, Arizona State University, United States*

Wednesday, January 10 10:00 - 10:20
Event Engineering Center Main Lobby

## Break

Wednesday, January 10 10:20 - 12:00
G2 Room 200

## Ionospheric Radio and Propagation

Session Co-Chairs: Charles Rino, Boston College; Sam Shidler, The University of Texas at Austin

**G2.1** **10:20**
TEC Structure Diagnostics
*Charles Rino, Charles Carrano, Keith Groves, Boston College, United States; Romina Nikoukir, Johns Hopkins University, United States*

**G2.2** **10:40**
Magnetic Anomalies Potentially Attributed to Perseid Bolide Reentry
*Mickey Batson, Laboratory for Telecommunication Sciences, United States; Nicholas Donnangelo, Blaine Talbut, MITRE Corporation, United States*

**G2.3** **11:00**
Swarm-E GPS Observations of the Polar Cap Ionosphere
*Christopher Watson, Richard Langely, University of New Brunswick, Canada; Andrew Howarth, Andrew Yau, University of Calgary, Canada*

**G2.4** **11:20**
Forecasting the Ionosphere with Interpretable Transformer Networks
*Daniel Alford-Lago, Naval Information Warfare Center Pacific, United States; Chris Curtis, San Diego State University, United States; Alex Ihler, University of California Irvine, United States*

**G2.5** **11:40**
Generation of Super Low Frequency Signals at the HAARP Facility for Long Range Propagation
*Ryan Eskola, Mark Golkowski, University of Colorado Denver, United States*

Wednesday, January 10 10:20 - 11:40
J2 Room 265

## New Telescopes, Techniques, and Technologies & Observatory Reports II

Session Co-Chairs: Alyson Ford, University of Arizona; Steven Ellingson, Virginia Tech

**J2.1** **10:20**
Correlation Calibration: A Hybrid Calibration Tool for Next-Generation Radio Interferometers
*Robert Pascua, Jonathan Sievers, Adrian Liu, McGill University, Canada*

**J2.2** **10:40**
Recent Observations with the Mapper of the IGM Spin Temperature
*Hsin Chiang, McGill University, Canada*

**J2.3** **11:00**
LuSEE Night Ground Support Equipment.pdf
*Seth Curtin, Seth Curtin, University of California, Berkeley, United States*

**J2.4** **11:20**
ALBATROS: Paving the Way to the Cosmic Dark Ages
*Cherie K. Day, McGill University, Canada*

Wednesday, January 10 12:10 - 13:10
Event Math 100

## Women in Radio Science (WIRS) Business Meeting

Wednesday, January 10 | 13:20 - 14:20
Event | Math 100

## Student Paper Competition (SPC)

Session Chairs: Erdem Topsakal and Asimina Kiourti

Space-Time Nonlocal Metasurfaces for Event-Based Image Processing
Sedigheh Esfahani – Advisor: Andrea Alù
City University of New York

Meteor Head Echo Detection via a Convolutional Neural Network Trained on Synthetic Radar Data
Trevor Hedges – Advisor: Sigrid Elschot
Stanford University

In-Situ Calibration of Active Electronically Scanned Antenna Arrays through SAR Imaging
Duncan Madden – Advisor: Kamal Sarabandi
University of Michigan

Wednesday, January 10 | 14:20 - 14:40
Event | Engineering Center Main Lobby

## Break

Wednesday, January 10 | 14:40 - 16:00
E1 | Room 150

### Electromagnetic Environment and Interference

Session Co-Chairs: Robert Gardner, Consultant; Jane Lehr, University of New Mexico

**E1.1** 14:40
Assessing and Mitigating Aggregate Interference with Real-Time Spectral Brokering
*Samuel Hussey, Jonathan Swindell, Glauco Amigo, Adam Goad, Andrew Clegg, Charles Baylis, Robert Marks, Baylor University, United States*

**E1.2** 15:00
Linearizing Nonlinear Power-Amplifiers Post-Distortion Using Cubic Spline Coefficients
*James Gaudreau, Nicholas Ellis, Patrick Roblin, Joel Johnson, Justin Kuric, Richard Ridgway, Christopher Ball, Ohio State University, United States*

**E1.3** 15:20
Towards Enhanced Bandwidth in TWTs: An Exploration of Helix Structure Optimization
*Maza Mohamed, Jane Lehr, University of New Mexico, United States*

**E1.4** 15:40
Scaling Laws for Solid-State Opening Switch Generators
*David Smith, Jane Lehr, University of New Mexico, United States*

Wednesday, January 10 | 14:40 - 16:20
B3 | Special Session | Room 151

### Progress in Reconfigurable Intelligent Surfaces (RIS)

Session Co-Chairs: Filippo Capolino, University of California, Irvine; Satish Sharma, San Diego State University

**B3.1** 14:40
Heterogeneous Integration of Biasing Circuits for mmWave Reconfigurable Intelligent Surfaces
*Russell Raldiris Torres, Aditya Shekhawat, Bharath Kashyap, Georgios Trichopoulos, Arizona State University, United States*

**B3.2** 15:00
Full RIS-domain Standing Waves for Elements' Biasing
*Miguel Saavedra-Melo, Kasra Rouhi, Benjamin Bradshaw, Filippo Capolino, University of California, Irvine, United States*

**B3.3** 15:20
A Compact Single-Bit Dual-Pol Unit Cell Design for mmWave Reconfigurable Intelligent Surfaces
*Aditya Shekhawat, Georgios Trichopoulos, Arizona State University, United States*

**B3.4** 15:40
Wideband, Polarization-Agile Reconfigurable Intelligent Surfaces
*Sanghamitro Das, Satish Sharma, San Diego State University, United States*

**B3.5** 16:00
BPSK Modulation Using Programmable Metasurfaces
*Aditya Shekhawat, Aaron Grace, Georgios Trichopoulos, Arizona State University, United States*

Wednesday, January 10 | 14:40 - 16:00
H1 | Special Session | Room 155

### Ionospheric Modification

Session Co-Chairs: Mark Golkowski, University of Colorado Denver; Eliana Nossa, Aerospace

**H1.1** 14:40
Evolution of Artificial Ionospheric Irregularities: Dependence on HAARP Beam Pattern
*Erin Lay, Ian Cummings, Christopher Jeffery, Los Alamos National Laboratory, United States; Paul Bernhardt, Mike McCarrick, University of Alaska Fairbanks, United States*

**H1.2** 15:00
A Study of Bistatic Coherent Radar Imaging of Ionospheric Irregularities using Simulated Data
*Christopher Jeffery, Ian Cummings, Erin Lay, Los Alamos National Laboratory, United States*

**H1.3** 15:20
Controlled Whistler Mode Wave Injection Experiments with the HAARP facility
*Mark Golkowski, Raahima Khatun-E-Zannat, Ryan Eskola, University of Colorado Denver, United States; Robert Moore, University of Florida, United States*

**H1.4** 15:40
Ionospheric Amplification of Whistler Mode Waves for Reduction of Radiation Belt Particle Populations
*Paul Bernhardt, University of Alaska Fairbanks, United States; Man Hua, Jacob Bortnik, University of California Los Angeles, United States; Carl Siefring, Naval Research Laboratory, United States; Qianli Ma, University of California Los Angeles, United States*

Wednesday, January 10 | 14:40 - 16:00
D2 | Special Session | Room 200

### RF Front-ends and Arrays for Simultaneous Transmit and Receive Operation

Session Chair: Laila Fighera Marzall, University of Colorado at Boudler

**D2.1** 14:40
In-Band Full-Duplex Array Architectures and Performance Survey
*Kenneth E. Kolodziej, MIT Lincoln Laboratory, United States; Zoya Popovic, University of Colorado, Boulder, United States*

**D2.2** 15:00
Broadband GaN MMICs for Analog Interference Suppression
*Paige Danielson, Zoya Popovic, University of Colorado Boulder, United States*

**D2.3** 15:20
Miniaturization of RF SIC Filter on High-K Ceramic Substrate for STAR Application
*Md Rakibur Rahman, Satheesh Bojja-Venkatakrishnan, Markondeyaraj Pulugurtha, John Volakis, Florida International University, United States*

**D2.4** 15:40
40-44 GHz MMIC Frequency Tunable Butler Matrix
*Laila Marzall, Zoya Popovic, University of Colorado Boulder, United States*

Wednesday, January 10 14:40 - 16:20
F2 Room 245

## Random and Complex Media Models in Remote Sensing

Session Co-Chairs: Gary Brown, Virginia Tech; Saba Mudaliar, Air Force Research Laboratory

**F2.1** **14:40**
Incoherent Scattering from an Object Above a Rough Surface
*Joseph Gedney, Joel Johnson, Robert Burkholder, The Ohio State University, United States*

**F2.2** **15:00**
Discontinuous Galerkin Method for Radiation Transfer in Plane-Parallel Semi-Transparent Media with Continuous Variable Refractive Index
*Md Ershadul Haque, Hang Wang, Abedi Reza, University of Tennessee Space Institute, United States; Mudaliar Saba, Air Force Research Laboratory, Wright-Patterson AFB, United States*

**F2.3** **15:20**
Snow Dielectric Constant Measurement from Brewster's Angle Using sUAS-Based Bistatic Radar
*Omid Reyhanigalangashi, Drew Taylor, Jordan Larson, Shiriniwas Kolpuke, Feras Abushakra, Aabhash Bhandari, Siva Prasad Gogineni, The University of Alabama, United States*

**F2.4** **15:40**
Significant Wave Height Estimation Using UAV
*Elizabeth Shi, Caglar Yardim, Joe Vinci, Ohio State University, United States*

**F2.5** **16:00**
Spectral Optical Theorem and Radiative Transport Equation in Random Media with Large Scale Fluctuations
*Saba Mudaliar, Air Force Research Laboratory, United States*

Wednesday, January 10 14:40 - 16:20
J3 Room 265

## New Telescopes, Techniques, and Technologies & Observatory Reports III

Session Co-Chairs: Alyson Ford, University of Arizona; Steven Ellingson, Virginia Tech

**J3.1** **14:40**
Drone-based Beam Mapping of the Array of Long Baseline Antennas for Taking Radio Observations from the Seventy-ninth parallel (ALBATROS)
*Lawrence Herman, McGill University, Canada*

**J3.2** **15:00**
Correcting Relative Clock Drift Between Independently-Clocked Antennas Of ALBATROS Radio Telescope Using ORBCOMM Satellites
*Mohan Agrawal, McGill University, Canada*

**J3.3** **15:20**
White Rabbit: Precision Time and Frequency Distribution for PANOSETI And High-Speed data transportation between NIC and GPU over 400G network
*Wei Liu, Dan Werthimer, University of California, Berkeley, United States; Mitchell C. Burnett, Brigham Young University, United States; Jonathon Kocz, University of California, Berkeley, United States; Rick Raffanti, techneinstruments, United States*

**J3.4** **15:40**
Deployment of an RFSoC-Based Correlator at the Deep Dish Development Array
*Ian Hendricksen, McGill University, Canada*

**J3.5** **16:00**
Profiling and Optimizing the High Performance Gridder
*Preshanth Jagannathan, Sanjay Bhatnagar, Martin Pokorny, NRAO, United States*

Wednesday, January 10 14:40 - 16:20
B4 Room 1B40

## Antenna, Theory, and Design II

Session Co-Chairs: John Volakis, FIU; Karl Warnick, Brigham Young University

**B4.1** **14:40**
mm-Wave UWB Tightly Coupled Dipole Array Realized Using a Hybrid PCB – 3D Printing Fabrication Approach
*Michail Anastasiadis, FIU, United States; Md Rakibul Islam, Galtronics USA Ltd., United States; Jorge Caripidis Troccola, John Volakis, FIU, United States*

**B4.2** **15:00**
Planar Reflection-less Lens Based on Miniaturized-element Frequency Selective Surfaces for Automotive Radar Applications
*Ehsan Hafezi, Kamal Sarabandi, University of Michigan, United States*

**B4.3** **15:20**
MIMO WiFi Imaging based on Reconfigurable Passive EM Skins
*Joseph Faia, Danilo Erricolo, University of Illinois Chicago, United States; Giacomo Oliveri, ELEDIA Research Center University of Trento, Italy*

**B4.4** **15:40**
Wideband Analog Interference Cancellation Using True Time Delays, Hadamard Projections, and a Kronecker Decomposition Algorithm
*Devon Ward, Student at Brigham Young University, United States; Karl Warnick, Brigham Young University, United States*

**B4.5** **16:00**
Substrate Integrated Impedance Surface and Their Applications in Waveguide and Antenna Technologies
*Asim Alkhaibari, Pai-Yen Chen, Danilo Erricolo, University of Illinois Chicago, United States*

Wednesday, January 10 16:20 - 17:20
Event Room 1B40

## Commission B Business Meeting

Wednesday, January 10 16:20 - 17:20
Event Room 200

## Commission D Business Meeting

Wednesday, January 10 16:20 - 17:20
Event Room 245

## Commission F Business Meeting

Wednesday, January 10 16:20 - 17:20
Event Room 150

## Commissions C & E Business Meeting

Wednesday, January 10 17:20 - 18:20
Event Room 265

## Commission J Business Meeting

Wednesday, January 10 17:20 - 18:20
Event Room 105

## Commission A Business Meeting

| Wednesday, January 10 | 17:20 - 18:20 |
|---|---|
| Event | Room 155 |

### Commission G Business Meeting

| Wednesday, January 10 | 18:30 - 21:00 |
|---|---|
| Event | Embassy Suites |

### 50th Anniversary Banquet & SPC Awards

Thursday, January 11 08:20 - 11:15
Event Math 100

## 50th Anniversary Plenary Session

Thursday, January 11 10:00 - 10:15
Event Math 100 Lobby

## Break

Thursday, January 11 11:30 - 13:15
Event KOBL S100

## Student Mentoring Luncheon

Thursday, January 11 13:30 - 17:10
BK5 Special Session Room 150

### Advances in Wireless Power Transfer and Harvesting for Biomedical Communication and Applications

Session Co-Chairs: Sima Noghanian, CommScope Ruckus Wireless Networks; Yahya Rahmat-Samii, University of California Los Angeles

**BK5.1** **13:30**
Body-Worn Hubs in Medical Applications: Enabling Self-Powered Wearables for Connected and Personalized Health Monitoring and Beyond
*Dieff Vital, University of Illinois Chicago, United States*

**BK5.2** **13:50**
Experimental Parametric Study of Dual-Layer Planar Wearable Magnetoinductive Waveguides
*Connor Jenkins, Asimina Kiourti, The Ohio State University, United States*

**BK5.3** **14:10**
Liquid Metal Nanoparticles-Infused Wearable CSCMR WPT Systems
*Juan Barreto, Abdul-Sattar Kaddour, Florida International University, United States; Hyeon Seok An, Robert F. Shepherd, Cornell University, United States; Constantinos L. Zekios, Stavros V. Georgakopoulos, Florida International University, United States*

**BK5.4** **14:30**
Non-Uniform Metasurface for Improving the Inductive Wireless Power Transfer Efficiency
*Sima Noghanian, CommScope Ruckus Wireless, United States; Abbas Ali Lotfi Neyestanak, Medical Cytometrix Inc, Canada; Maryam Heshmathzadeh, British Columbia Institute of Technology, Canada*

**BK5.5** **14:50**
Incorporation of DNG Metamaterial for Enhancing Efficiency of RF WPT
*Zhanel Kudaibergenova, Mohammad Hashmi, Galymzhan Nauryzbayev, Nazarbayev University, Kazakhstan*

**Break** **15:10**

**BK5.6** **15:30**
Self-Powered Wearable Devices Integrated with Virtual Reality Simulation Clinics: A Novel Approach to Healthcare Modernization
*Benjamin Martinez, Adrian Velazquez, Dieff Vital, University of Illinois Chicago, United States*

**BK5.7** **15:50**
Full-Body Case Study of Wearable Magnetoinductive Waveguides
*Connor Jenkins, Asimina Kiourti, The Ohio State University, United States*

**BK5.8** **16:10**
Textile RFIDs for Healthcare Applications
*Michael Suche, Lauren Linkous, Erdem Topsakal, Virginia Commonwealth University, United States*

**BK5.9** **16:30**
Textile-Based Reconfigurable Dual-Band Frequency Selective Surface for WMTS and CBRS
*Amber Nunnally, Erdem Topsakal, Virginia Commonwealth University, United States*

**BK5.10** **16:50**
Study of an E textile rectangle tapered slot Vivaldi antenna for energy harvesting applications
*Varsha Kheradiya, Ganga Prasad Pandey Ganga Prasad Pandey, Pandit deendayal Energy university, India*

Thursday, January 11 13:30 - 17:10
B6 Room 151

### Propagation, Scattering, and Sensing I

Session Co-Chairs: Branislav Notaros, Colorado State University; Franco De Flaviis, University of California, Irvine; Zoya Popovic, University of Colorado Boulder

**B6.1** **13:30**
A Theoretical Model for Finite-Element Magnetoinductive Waveguides
*Samuel Coogle, Connor Jenkins, Asimina Kiourti, The Ohio State University, United States*

**B6.2** **13:50**
Circuit analysis of crosstalk in a parallel plate waveguide containing an internal perforated sheet
*Edward Kuester, University of Colorado, United States; Nick Krull, Electronic Expertise Ltd, United States*

**B6.3** **14:10**
Near-Field Radiometry with Spatial Focusing
*Joseph Dunbar, University of Colorado Boulder, United States; Gabriel Santamaria Botello, Colorado School of Mines, United States; Zoya Popovic, University of Colorado Boulder, United States*

**B6.4** **14:30**
Scattering by an Octant -Sphere Located Inside a Trihedral Reflector
*Sahitya Singh, Graduate Center of the City University of New York, United States; Piergiorgio L. E. Uslenghi, University of Illinois at Chicago, United States*

**B6.5** **14:50**
Pulsed Non-coherent QPSK Low Probability of Intercept Waveforms for Commercial Software-Defined Radios
*John Willis, Satheesh Venkatakrishnan, John Volakis, Florida International University, United States*

**Break** **15:10**

**B6.6** **15:30**
Convolutional Neural Networks for Subsurface Electrical Properties Estimation
*Sahar Bagherkhani, Saeid Alamdar, Franco De Flaviis, University of California, Irvine, United States*

**B6.7** **15:50**
Advances in Geometrical Classification of Snowflakes Using AI and Images Collected by the Multi-Angle Snowflake Camera
*Hein Thant, Isaac Jacobson, Branislav Notaros, Colorado State University, United States*

**B6.8** **16:10**
Exact Solution for a Dipole above Two-Layered Semi-Oblate Spheroidal Cavity
*Anastasiia Rozhkova, University of Illinois Chicago, United States; Ermanno Citraro, Politecnico di Torino, Italy; Danilo Erricolo, University of Illinois Chicago, United States; Francesco Andriulli, Politecnico di Torino, Italy*

**B6.9** **16:30**
Downscaling the GOES ABI Data in Support of High-Resolution Wildfire Mapping
*Yifan Yang, Haonan Chen, Colorado State University, United States*

**B6.10** **16:50**
On the Potential of Passive Metasurface Skins for Enhanced Biomedical Imaging
*Amin Rastgordani, Danilo Erricolo, University of Illinois Chicago, United States; Giacomo Oliveri, University of Trento, Italy*

Thursday, January 11 13:30 - 15:10
H2 Special Session Room 155

### Active Experiments in Laboratory and Space Plasmas

Session Co-Chairs: Bill Amatucci, Naval Research Laboratory; Erik Tejero, Naval Research Laboratory

**H2.1** **13:30**
Fast Ion Injection in the Large Plasma Device to Model EMIC and Fast Wave Excitation in the Magnetosphere
*Stephen Vincena, Shreekrishna Tripathi, UCLA, United States*

**H2.2** **13:50**
Quantifying the Effects of Electron Shot Noise on a Current Biased Antenna
*Winry Ember, Marc Pulupa, Stuart D. Bale, University of California, Berkeley, United States*

**H2.3** **14:10**
First Results from the LIEFSI Campaign – Setup and Calibration
*Justin Bowman, West Virginia University, United States; Erik Tejero, U.S Naval Research Laboratory, United States; John Bonnell, University of California, United States; William Amatucci, U.S Naval Research Laboratory, United States; Katherine Goodrich, West Virginia University, United States*

**H2.4** **14:30**
First Results from the LIEFSI Campaign – Interpretations and Applications
*John Bonnell, Univ. of California, Berkeley, United States; Justin Bowman, Katherine Goodrich, West Virginia University, United States; Erik Tejero, William Amatucci, U.S. Naval Research Laboratory, United States*

**H2.5** **14:50**
Plasma Impedance Tomography: A Noninvasive Plasma Imaging Diagnostic
*Erik Tejero, George Gatling, Matt Paliwoda, Ami DuBois, Bill Amatucci, Naval Research Laboratory, United States*

Thursday, January 11 13:30 - 15:10
D3 Special Session Room 200

## Hyperspectral Sensing for Space Applications

Session Co-Chairs: Negar Ehsan, NASA; Akim Babenko, Jet Propulsion Laboratory

**D3.1** **13:30**

Digital Spectrometer ASICs Are Enabling Hyperspectral Microwave Sensing

*Priscilla Mohammed, Morgan State University, United States; Paul Racette, NASA Goddard Space Flight Center, United States; Gytis Baranauskas, Dalius Baranauskas, Denis Zelenin, Pacific MicroChip Corporation, United States*

**D3.2** **13:50**

Broadband Hyperspectral Sounders for Atmospheric Remote Sensing

*Akim Babenko, Omkar Pradhan, Ahmed Mohamed, Shannon Brown, Alan Tanner, Niyati Shah, Pekka Kangaslahti, Javier Bosch-Lluis, Joan Munoz-Martin, Jet Propulsion Laboratory, United States*

**D3.3** **14:10**

New Microwave Reflectarrary Technology to Enable Hyperspectral Microwave Sounding

*William Blackwell, Cara Kataria, William Moulder, MIT Lincoln Laboratory, United States*

**D3.4** **14:30**

Photonic-integrated modulators as millimeter and submillimeter-wave hyperspectral receivers with no pre-amplification

*Gabriel Santamaria-Botello, Colorado School of Mines, United States*

**D3.5** **14:50**

Rydberg Atoms for Hyperspectral Radiometry in the Planetary Boundary Layer

*Shane Verploegh, Eric Bottomley, Michelle Warter, John Guthrie, Infleqtion, United States*

Thursday, January 11 13:30 - 17:10
FGH3 Special Session Room 245

## Remote Sensing Using GNSS-R and SoOp Systems

Session Co-Chairs: Clara Chew, Muon Space; Mohammad Al-Khaldi, The Ohio State University; Yang Wang, University of Colorado Boulder

**FGH3.1** **13:30**

The NASA CYGNSS Mission and its Tropical Cyclone Measurement Capabilities

*Christopher Ruf, University of Michigan, United States; April Warnock, SRI International, United States; Rajeswari Balasubramaniam, University of Michigan, United States*

**FGH3.2** **13:50**

A Blended CYGNSS Soil Moisture Product Partitioned with Ancillary Data

*Erik Hodges, University of Southern California, United States; Clara Chew, Muon Space, United States; Eric Small, University of Colorado,, United States; Mohammad Al, The Ohio State University, United States; Jeffrey D. Ouellette, U.S. Naval Research Laboratory, United States; Joel T. Johnson, The Ohio State University, United States; Fangni Lei, University of Connecticut, United States; Mehmet Kurum, University of Georgia, United States; Ali Gurbuz, Volkan Senyurek, Mississippi State University, United States; Xiaolan Xu, Rashmi Shah, Simon Yueh, Akiko Hayashi, Jet Propulsion Laboratory, California Institute of Technology, United States; Paulo T. Setti Jr., Sajad Tabibi, University of Luxembourg, Luxembourg; Emanuele Santi, Simone Pettinato, National Research Council – Institute of Applied Physics (CNR-IFAC), Italy; T. Max Roberts, Ian Colwell, Stephen Lowe, Muon Space, United States; Christopher S. Ruf, University of Michigan, United States; Mahta Moghaddam, University of Southern California, United States*

**FGH3.3** **14:10**

GNSS-R Wetland Monitoring

*Luke Redwine, Mehedi Farad, Kurum Mehmet, Ali Gurbuz, Mississippi State University, United States*

**FGH3.4** **14:30**

An Approach For Reservoir Water Level Retrievals Using CYGNSS Level-1 Observations and Complimentary Ancillary Datasets

*Nicholas Brendle, The Ohio State University, United States; Steven Chan, George Hajj, California Institute of Technology, United States; Joel Johnson, Mohammad Al-Khaldi, The Ohio State University, United States*

**FGH3.5** **14:50**

GNSS Signals of Opportunity Synthetic Aperture Radar Concept for High Resolution Imaging of Terrain Surfaces

*Simon Yueh, Rashmi Shah, Tianlin Wang, Xiaolan Xu, California Institute of Technology, United States*

**Break** **15:10**

**FGH3.6** **15:30**

Passive L-band GNSS-R and Active C- and Ka-band Radar Inland Water Wind Speeds

*Jessica Fayne, University of Michigan, United States; Mohammad Al-Khaldi, The Ohio State University, United States*

**FGH3.7** **15:50**

Exploiting Dense Coherent Reflection Track Areas in the Indonesian Seas to Investigate the Performance of Spire GNSS-R Ocean Altimetry

*carolyn Roesler, Jade Morton, University of Boulder Colorado, United States*

**FGH3.8** **16:10**

Studying changes in permafrost areas using GNSS reflections

*Jiahua Zhang, Jade Morton, University of Colorado Boulder, United States*

**FGH3.9** **16:30**

GNSS Reflectometry for Remote Sensing of Ross Ice Shelf Surface Topography

*Sophie Anderson, Yang Wang, Jade Morton, University of Colorado Boulder, United States*

**FGH3.10** **16:50**

Initial evaluation of PlanetiQ grazing GNSS coherent reflections for altimetry applications

*Y. X. Xiao, C. K. Shum, Ohio State University, United States; E. R. Kursinski, J. Brandmeyer, X. Feng, PlanetiQ, United States*

Thursday, January 11 13:30 - 15:10
J3 Special Session Room 265

## RFI Mitigation and Spectrum Management I

Session Co-Chairs: Frank K. Schinzel, NRAO; David DeBoer, University of California Berkeley

**J3.1** **13:30**
The Radio Frequency Interference Environment of the Very Large Array
*Frank K. Schinzel, Pedro P.B. Beaklini, Chris D. De Pree, Bang Nhan, Evangelia Tremou, NRAO, United States*

**J3.2** **13:50**
Near Real-Time Radio Frequency Interference Monitoring Database for the Very Large Array
*Preshanth Jagannathan, Brian Kirk, Alan Erickson, NRAO, United States*

**J3.3** **14:10**
Radio Frequency Interference (RFI) Geolocation for Radio interferometers
*Mark Ruzindana, David DeBoer, University of California Berkeley, United States; Alexander Pollak, Wael Farah, Hat Creek Radio Observatory, United States; Kevin Gifford, Arvind Aradhya, Stefan Tschimben, University of Colorado Boulder, United States; Cole Forrester, Brockton Stover, Aaron Parsons, Josh Dillon, University of California Berkeley, United States*

**J3.4** **14:30**
RFI Issues for the next generation Very Large Array (ngVLA)
*Bryan Butler, Urvashi Rao, Rob Selina, Chris De Pree, NRAO, United States*

**J3.5** **14:50**
RFI considerations for the DSA-2000
*Gregory Hellbourg, California Institute of Technology, United States*

Thursday, January 11 13:30 - 17:10
BF7 Special Session Room 1B40

## Quantum Technology Applications in Electromagnetics and Remote Sensing

Session Co-Chairs: Saba Mudaliar, Air Force Research Laboratory; Thomas Roth, Purdue University

**BF7.1** **13:30**
Investigating Quantum Entanglement Using Canonical Quantization and Scattering Theory
*Jie Zhu, Purdue University, United States; Dong-Yeop Na, Pohang University of Science and Technology, Korea (South); Weng Chew, Purdue University, United States*

**BF7.2** **13:50**
Towards an Analytical Quantum Full-Wave Solution of a Transmon Qubit in a 3D Microwave Cavity
*Soomin Moon, Thomas Roth, Purdue University, United States*

**BF7.3** **14:10**
Efficient Sources of Entangled Single-Photon Pairs with Nonlinear Plasmonic Metasurfaces
*Sky Semone, Christos Argyropoulos, The Pennsylvania State University, United States*

**BF7.4** **14:30**
Rydberg Atom Based Sensors: Radio-Frequency Field Detection to Remote Sensing and Other Receiving Applications
*Christopher Holloway, Andrew Rotunno, Samuel Berweger, Matthew Simons, Alexandra Artusio-Glimpse, Nikunjkumar Prajapati, Eric Norrgard, Stephen Eckel, NIST, United States; Noah Schlossberger, University of Colorado, United States*

**BF7.5** **14:50**
Quantum Theory and Questions as Viewed from Classical EM
*Akira Ishimaru, University of Washington, United States*

**Break** **15:10**

**BF7.6** **15:30**
Quantum Statistical Aspects of Emission and Absorption in Remote Sensing and Imaging
*Saba Mudaliar, Air Force Research Laboratory, United States*

**BF7.7** **15:50**
Calculating Multi-Qubit Exchange Coupling Rates for Transmon Qubits Using a Field-Based Formalism
*Ghazi Khan, Thomas Roth, Purdue University, United States*

**BF7.8** **16:10**
Compact Cryocooled RF Direction Finder
*Masoud Radparvar, Hypres, United States*

**BF7.9** **16:30**
Sub-wavelength angle-of-arrival measurement at 1.1 GHz in a Rydberg vapor using a three-color, all near-infrared excitation
*Eric Bottomley, Haoquan Fan, Shane Verploegh, Infleqtion, United States*

**BF7.10** **16:50**
Computational electromagnetic challenges in designing superconducting qubit devices
*Ebrahim Forati, Google Quantum AI, United States*

Thursday, January 11 15:10 - 15:30
Event Engineering Center Main Lobby

## Break

Thursday, January 11 15:30 - 17:10
C1 Room 105

## Adaptive RADAR and Array Signal Processing Techniques

Session Co-Chairs: Fikadu T. Dagefu, DEVCOM Army Research Laboratory; Mark Golkowski, University of Colorado Denver; Dev Palmer, DARPA; Vijay Harid, University of Colorado Denver

**C1.1** **15:30**
Low Probability of Detection Communication via Polarization Diversity: An Experimental Study
*Morriel Kasher, Rutgers University, United States; Fikadu T. Dagefu, Jihun Choi, DEVCOM Army Research Laboratory, United States; Chryssalenia Koumpouzi, Predrag Spasojevic, Rutgers University, United States*

**C1.2** **15:50**
Predistortion for a X-band Wave-Sensing Radar Power Amplifier
*John Mower, University of Washington, United States*

**C1.3** **16:10**
Signal Classification for Spectrum Sharing with Machine Learning Using a Low-Cost SDR
*Akimun Jannat Alvina, University of Colorado Denver, United States; Yao Ma, National Institute of Standards and Technology, United States; Vijay Harid, Mark Golkowski, University of Colorado Denver, United States*

**C1.4** **16:30**
Progress towards quantum-enhanced microwave remote sensing and communication applications
*Jérôme Bourassa, Qubic Inc., Canada; Christopher Wilson, Qubic Inc & University of Waterloo, Canada*

**C1.5** **16:50**
From Laboratory to Platform: The Impact of Adaptive Spectrum Usage on Microwave Test and Measurement
*Charles Baylis, Austin Egbert, Andrew Clegg, Robert Marks, Baylor University, United States*

Thursday, January 11 15:30 - 17:10
H3 Special Session Room 155

## Physics of the Radiation Belts: Coupling of Different Plasma Populations by Means of Plasma Waves

Session Co-Chairs: Oleksiy Agapitov, University of California Berkeley; Maria Usanova, UC Boulder; Lunjin Chen, UT Dallas

**H3.1** **15:30**
Energy Coupling from Magnetosonic Waves to High-Frequency Electromagnetic Ion Cyclotron Waves: Statistical Analysis
*Kyungguk Min, Chungnam National University, Korea (South); Qianli Ma, University of California, Los Angeles, United States*

**H3.2** **15:50**
Whistler-Mode Waves In the Inner Magnetosphere: Recent Progress on Statistics and Spatial Distributions
*David Malaspina, University of Colorado, Boulder, United States; Jean-François Ripoll, Melanie Cosmides, Thomas Farges, Commission for Atomic Energy and Alternative Energies, France*

**H3.3** **16:10**
Simulation Study of Whistler Mode Waves in the Magnetosphere Using Ray Tracing and Finite Difference Time Domain (FDTD) Models
*Raahima Khatun-E-Zannat, Vijay Harid, Mark Golkowski, University of Colorado Denver, United States; Oleksiy Agapitov, University of California, Berkley, United States*

**H3.4** **16:30**
Local Acceleration of Relativistic Electrons to Ultra-Relativistic Energy Due to Fast Magnetosonic Waves and Whistler-Mode Chorus Waves
*Livia Alves, National Institute for Space Research (INPE), Brazil; Ligia da Silva, National Institute for Space Research (INPE); State Key Laboratory for Space Weather, Beijing - China, Brazil; Graziela Silva, National Institute for Space Research (INPE), Brazil; Jose Marchezi, University of New Hampshire, United States; Karen Ferreira, National Institute for Space Research (INPE), Brazil; David G. Sibeck, Shrikanth G. Kanekal, NASA Goddard Space Flight Center, United States*

**H3.5** **16:50**
Determining When, Where, and Why Radiation Belt Dropouts Do and Don't Occur
*Lauren Blum, Stanislaus Nnadih, LASP, United States; Craig Rodger, University of Otago, New Zealand; Zheng Xiang, Wuhan University, China; Weichao Tu, Xingzhi Lyu, West Virginia University, United States; Domenique Freund, University of Colorado Boulder, United States*

Thursday, January 11 | 15:30 - 17:30
G3 | Special Session | Room 200

**Beacon Satellite Science and Applications: In Memory of Patricia Doherty**

Session Co-Chairs: Keith Groves, Boston College; Anthea Coster, MIT Haystack; Sigrid Eischot

**G3.1** 15:30
Confirmation of a Power Law Phase Screen Theory Relating TEC Rate of Change and Scintillation Indices at Equatorial and High Latitudes
*Charles Carrano, Teddy Espejo, Keith Groves, Boston College, United States*

**G3.2** 15:50
Observing More Equatorial Irregularity Physics Using GNSS Scintillation Parameters
*Theodore Beach, Keith Groves, Christopher Bridgwood, Matthew Proctor, Dima Paznukhov, Boston College, United States*

**G3.3** 16:10
Ionospheric Gradients Assessment for GBAS operations in Low-latitude Regions
*Teddy Surco Espejo, Charles Carrano, Keith Groves, Institute for Scientific Research/Boston College, United States*

**G3.4** 16:30
Instability Variability Characteristics Derived from Beacon Satellite Observations
*Keith Groves, John Retterer, Charles Carrano, Christopher Bridgwood, Boston College, United States*

**G3.5** 16:50
A distributed array of low-cost GNSS-based sensors for monitoring and studies of mid-latitude ionospheric irregularities and scintillation
*Josemaria Gomez Socola, Fabiano Rodrigues, University of Texas at Dallas, United States*

**G3.6** 17:10
Spatial Imaging and Zonal Drift Motion Tracking of Equatorial Plasma Bubbles over South America Using Specially Detrended GPS TEC Data
*Rezy Pradipta, Boston College, United States*

Thursday, January 11 | 15:30 - 17:30
J4 | Special Session | Room 265

**ngVLA Antenna Development**

Session Co-Chairs: Rob Selina, National Radio Astronomy Observatory; Eric Murphy, National Radio Astronomy Observatory

**J4.1** 15:30
ngVLA 18m Antenna Design & Prototype Project Overview
*Willem Esterhuyse, Anthony Beasley, Robert Selina, National Radio Astronomy Observatory, United States*

**J4.2** 15:50
ngVLA Antenna Technology and Prototype Status
*Lutz Stenvers, mtex antenna technology, Germany*

**J4.3** 16:10
Updates on the Optics Design of the ngVLA 18-meter Reflector System
*Robert Lehmensiek, NRAO, United States*

**J4.4** 16:30
Antenna Electronics Design for the Next-Generation Very Large Array
*James Jackson, National Radio Astronomy Observatory, United States*

**J4.5** 16:50
ngVLA Antenna Prototype Electronics and Radiometric Testing
*Robert Long, National Radio Astronomy Observatory, United States*

**J4.6** 17:10
Front End Subsystem Development for a Next Generation Very Large Array
*Wes Grammer, Silver Sturgis, NRAO, United States*

Thursday, January 11 | 17:30 - 18:30
Event | Room 155

**Commission H Business Meeting**

Thursday, January 11 | 17:30 - 18:30
Event | Room 150

**Commission K Business Meeting**

Thursday, January 11 | 19:00 - 20:30
Event | Embassy Suites

**WIRS Reception (Ticket Required, Contact WIRS Leadership)**

Friday, January 12 06:15 - 08:00
Event

## USNC-URSI Executive Council Meeting – Invitation Only

Friday, January 12 08:20 - 10:00
A1 Special Session Room 105

### Clutter, Noise, Troposcatter Measurements and Models

Session Co-Chairs: Adam Hicks, The Institute for Telecommunication Sciences; Christopher Anderson, NTIA

**A1.1** **08:20**
The Impact of Seasonal Foliage Changes on Clutter Modeling
*William Kozma Jr., Adam Hicks, Brian Lain, The Institute for Telecommunication Sciences, United States*

**A1.2** **08:40**
Preliminary Mid-Band Troposcatter Measurement Results using Different High-Gain Receiver Antennas
*Adam Hicks, Jim McLean, John Ewan, Institute for Telecommunication Sciences, United States*

**A1.3** **09:00**
An in situ characterization of 1.7 GHz building entry loss
*Christopher Anderson, NTIA, United States*

**A1.4** **09:20**
Spatial Structure of the Urban RF Noise Field in Boston, MA
*Aaron Meyer, Daniel Breton, Matthew Kamrath, Sergey Vecherin, ERDC-CRREL, United States*

**A1.5** **09:40**
An Improved-Accuracy Discrete Sampling Criterion for the Estimation of the Local Mean Voltage of a Mobile Radio Channel
*Robert Johnk, John Lemmon, Roger Dalke, Institute for Telecommunication Sciences (NTIA/ITS), United States*

Friday, January 12 08:20 - 10:00
B8 Room 151

### Propagation, Scattering, and Sensing II

Session Co-Chairs: Majid Manteghi, Virginia polytechnic institute and state university; Praveen Sekhar, Washington State University Vancouver; Charles Baylis, Baylor University; Satish Sharma, San Diego State University

**B8.1** **08:20**
An In-Situ Measurement System Using Downconversion
*Trevor Van Hoosier, Emma Lever, Adam Goad, Samuel Hussey, Jonathan Swindell, Charles Baylis, Baylor University, United States; Albin Gasiewski, Aravind Venkitasubramony, University of Colorado, United States; Robert Marks, Baylor University, United States*

**B8.2** **08:40**
Active Low-Noise Matching with Subharmonic Parametric Amplifier
*Fatemeh Sadr, Majid Manteghi, Virginia polytechnic institute and state university, United States*

**B8.3** **09:00**
Wave Manipulating RIS for Enhanced Tomographic Imaging: Concept and Recent Advances
*Carlo Tortoriello, Danilo Erricolo, University of Illinois Chicago, United States; Giacomo Oliveri, Università degli Studi di Trento, Italy*

**B8.4** **09:20**
Transmission Through a Perforated Thick Metallic Screen
*Abdulaziz Haddab, The Public Authority for Applied Education and Training, Kuwait; Edward Kuester, University of Colorado Boulder, United States*

**B8.5** **09:40**
RF Characterization of Zirconia Ribbon Ceramic Using T-Resonator Method
*Abu Horaira Hridhon, Aleks Mertvyy, Md. Samiul Islam Sagar, Praveen Sekhar, Tutku Karacolak, Washington State University Vancouver, United States*

Friday, January 12 08:20 - 12:00
H4 Room 155

### Waves and Interactions in Plasmas

Session Co-Chairs: Chris Crabtree, US Naval Research Laboratory; Ashanthi Maxworth, University of Southern Maine

**H4.1** **08:20**
Whistler-Mode Waves in the Magnetic Ducts
*Anatoly Streltsov, Salman Nejad, Embry-Riddle Aeronautical University, United States*

**H4.2** **08:40**
Guiding of the whistler-mode waves by the localized depletions of the magnetic field
*Salman A. Nejad, Anatoly V. Streltsov, Embry-Riddle Aeronautical University, United States*

**H4.3** **09:00**
Association of Relativistic Microbursts Duration with Chorus Wave Properties
*Jiabei He, Lunjin Chen, Zhiyang Xia, The University of Texas at Dallas, United States*

**H4.4** **09:20**
Unveiling Zebra-like Patterns in Type III Radio Bursts: Multi-Spacecraft Observations
*Vratislav Krupar, UMBC and NASA, United States; Mychajlo Hajos, The Czech Academy of Sciences, Czech Republic*

**H4.5** **09:40**
Development of the Ambipolar Electric Field in a Compressed Current Sheet and the Impact on Magnetic Reconnection
*Ami DuBois, Chris Crabtree, Gurudas Ganguli, U.S. Naval Research Laboratory, United States*

**Break** **10:00**

**H4.6** **10:20**
Preliminary Findings of Stimulated Brillouin Scattering with Satellite Transmission
*Jason Ruszkowski, Edgar Bering, Andrew Renshaw, University of Houston, United States*

**H4.7** **10:40**
Geomagnetically conjugate measurements of radio emissions or auroral origin
*James LaBelle, Stephanie Damish, David McGaw, Terrence Kovacs, John Griffin, Dartmouth College, United States; Anton Kashcheyev, P. T. Jayachandran, University of New Brunswick, Canada*

**H4.8** **11:00**
Reduced-Order Modeling of Backward Wave Oscillator Fields for High-Power Microwave Applications
*Indranil Nayak, Fernando Teixeira, The Ohio State University, United States*

**H4.9** **11:20**
Observational Properties of Harmonic EMIC waves in the Earth magnetosphere
*Shujie Gu, Xu Liu, Lunjin Chen, Wenyao Gu, University of Texas at Dallas, United States*

**H4.10** **11:40**
ULF Quarter-Waves at High and Middle Latitudes
*Anatoly Streltsov, Embry-Riddle Aeronautical University, United States; Evgeny Mishin, AFRL, United States*

Friday, January 12 08:20 - 11:20
D4 Room 200

## Wide bandgap Semiconductors & Radar Applications

Session Co-Chairs: Charles Baylis, Baylor University; Filippo Capolino, University of California, Irvine; Jonathan Chisum, University of Notre Dame

**D4.1** **08:20**
Investigating high-gain in Gallium Nitride photoconductive switches.
*Nicolas Gonzalez, Jane Lehr, The University of New Mexico, United States*

**D4.2** **08:40**
Low-Loss D-band SIW Power Divider for Integrated Systems
*Weifeng Wu, University of Notre Dame, United States; Xiaopeng Wang, Lei Li, James Hwang, Cornell University, United States; Patrick Fay, University of Notre Dame, United States*

**D4.3** **09:00**
Amplified THz Detection in p-Diamond TeraFET Induced by Fixed Drain Current
*Muhammad Mahmudul Hasan, Nezih Pala, Florida International University, United States; Michael Shur, Rensselaer Polytechnic Institute, United States*

**D4.4** **09:20**
Multi-Dimensional Image Completion for Automated Power Amplifier Design
*Jonathan Swindell, Austin Egbert, Adam Goad, Sam Haug, Charles Baylis, Robert J. Marks II, Baylor, United States; Casey Latham, Matthew Ozalas, Andy Howard, Daren McClearnon, Keysight Technologies, United States*

**D4.5** **09:40**
Simultaneous Multidimensional Optimization for Fast Amplifier Design
*Adam Goad, Samuel Haug, Jonathan Swindell, Charles Baylis, Austin Egbert, Baylor University, United States; Casey Latham, Mathew Ozalas, Andy Howard, Daren McClearnon, Keysight Technologies, United States; Robert Marks, Baylor University, United States*

**Break** **10:00**

**D4.6** **10:20**
Real-Time Circuit Optimization for Simultaneous Radar and Communications: Pre-characterization and Live Measurement
*Samuel Haug, Austin Egbert, Adam Goad, Charles Baylis, Robert Marks, Baylor University, United States; Anthony Martone, DEVCOM Army Research Laboratory, United States*

**D4.7** **10:40**
Utilizing Distributed Circuit Topology Techniques to Achieve Reduced Maximum Branch Currents for High Power Impedance Matching RF Applications
*Justin Roessler, Austin Egbert, Trevor Van Hoosier, Charles Baylis, Robert Marks, Baylor University, United States; Dimitrios Peroulis, Purdue University, United States*

**D4.8** **11:00**
Second-order Exceptional Point of Degeneracy in Two Directly Coupled Resonator
*Kasra Rouhi, Alireza Nikzamir, Alexander Figotin, Filippo Capolino, University of California, Irvine, United States*

Friday, January 12 08:20 - 12:00
F4 Special Session Room 245

## Rough Surface Scattering and Electromagnetics: In Honor of Gary Brown

Session Co-Chairs: Jakov Toporkov, US Naval Research Laboratory; Joel Johnson, The Ohio State University; Ra'id Awadallah, Johns Hopkins University/Applied Physics Laboratory

**F4.1** **08:20**
Research and Service: Celebrating a Role Model in the Radio Science Community
*Michael Newkirk, Johns Hopkins University Applied Physics Lab, United States*

**F4.2** **08:40**
The Rayleigh Hypothesis in the Theory of Wave Scattering from Rough Surfaces
*Alexander Voronovich, NOAA/PSL, United States*

**F4.3** **09:00**
Analytical Modeling of Electromagnetic Fields Scattered from a Target in the Presence of a Rough Surface
*Joel Johnson, Joseph Gedney, Robert Burkholder, The Ohio State University, United States*

**F4.4** **09:20**
Appraisal of the Rice-squared Model for Scattering from an Object above a Sea Surface
*Ra'id Awadallah, Johns Hopkins University/Applied Physics Laboratory, United States*

**F4.5** **09:40**
Scattering from a Forest with an Underlying Rough Surface
*Roger Lang, George Washington University, United States*

**Break** **10:00**

**F4.6** **10:20**
TWO-SCALE SCATTERING MODEL: DETERMINING THE SCALE SEPARATION VIA DIRECT NUMERICAL SIMULATIONS
*Jakov Toporkov, US Naval Research Laboratory, United States*

**F4.7** **10:40**
Estimation of the Spectral Division Parameter in a Two-Scale Model for the Case of GNSS Ocean Reflectometry
*Valery Zavorotny, Colorado University Boulder, United States; Alexander Voronovich, National Oceanic and Atmospheric Administration, United States*

**F4.8** **11:00**
Group-based Compression of FMM Data Structures for Non-Oscillatory Kernels
*Robert Adams, John Young, Stephen Gedney, University of Kentucky, United States*

**F4.9** **11:20**
Additional Insight into the Method of Smoothing as Applies To Rough Surface Scattering
*Gary Brown, Virginia Tech, United States*

**F4.10** **11:40**
Discussion
*Community Discussion,*

Friday, January 12 | 08:20 - 11:20
J5 | Special Session | Room 265

## RFI Mitigation and Spectrum Management II

Session Co-Chairs: Frank K. Schinzel, NRAO; David DeBoer, University of California Berkeley

**J5.1** 08:20
Radio Frequency Interference Monitoring and Analysis for Ground-Based Cosmic Microwave Background Surveys
*Ian Birdwell, Darcy Barron, Stephen Luttrell, University of New Mexico, United States; Simon Matin, University of Nevada, Las Vegas, United States*

**J5.2** 08:40
New Results on Mitigation of Satellite Interference by Coherent Time-Domain Canceling
*Steven Ellingson, R. Michael Buehrer, Tom Anders, Xinrui Li, Virginia Tech, United States*

**J5.3** 09:00
Detection of Satellite Emission at Millimeter-Waves Using Cosmic Microwave Background Survey Instruments
*Allen Foster, Princeton University, United States; Aman Chokshi, The University of Melbourne, Australia*

**J5.4** 09:20
GRIDflag : A UV plane flagging algorithm for high fidelity interferometric imaging
*Srikrishna Sekhar, National Radio Astronomy Observatory, United States*

**J5.5** 09:40
Operational Data Sharing (ODS) Framework - A coexistence strategy for radio observatories in the broadband era
*Bang Nhan, Chris De Pree, Mark Whitehead, National Radio Astronomy Observatory, United States; Daniel Dueri, Matt Iverson, SpaceX, United States; Anthony Beasley, National Radio Astronomy Observatory, United States*

**Break** 10:00

**J5.6** 10:20
An Advanced Testbed for Passive/Active Coexistence Research: A Comprehensive Framework for RFI Detection, Mitigation, and Calibration
*Ahmed Manavi Alam, Md Mehedi Farhad, Mississippi State University, United States; Mehmet Kurum, University of Georgia, United States; Ali Gurbuz, Mississippi State University, United States*

**J5.7** 10:40
Facilitating Spectrum Sharing Between Passive and Active Users at a Prototype National Radio Dynamic Zone (NRDZ)
*Arvind Aradhya, University of Colorado, Boulder, United States; Andrew Clegg, Google, United States; David DeBoer, University of California, Berkeley, United States; Elliot Eichen, University of Colorado, Boulder, United States; Wael Farah, SETI Institute, United States; Cole Forrester, University of California, Berkeley, United States; Kevin Gifford, Sylvia Llosa, Mark Lofquist, Eloise Morris, Nicholas Papadopoulos, Bo Pearce, University of Colorado, Boulder, United States; Alexander Pollak, SETI Institute, United States; Mark Ruzindana, Brockton Stover, University of California, Berkeley, United States; Stefan Tschimben, Georgiana Weihe, University of Colorado, Boulder, United States*

**J5.8** 11:00
Dynamic RFI Management in Radio Astronomy using Pseudonymetry
*Gregory Hellbourg, California Institute of Technology, United States; Neal Patwari, Meles Weldegebriel, Ning Zhang, Washington University in St. Louis, United States*

Friday, January 12 | 08:20 - 10:00
B9 | Special Session | Room 1B40

## Multifunctional Antennas and Arrays for Satellite and Wireless Communications

Session Co-Chairs: Satish Sharma, San Diego State University; Jia-Chi Chieh, NIWC-Pacific

**B9.1** 08:20
Design, Fabrication, and Experimental Characterization of an Ultra-Wideband, Electronically-Reconfigurable Transmitarray Element with High Peak and Average Power Handling Capability
*Jinkai Wu, Halil Topözlü, Zongtang Zhang, Shiva Hajitabarmarznaki, John Booske, Nader Behdad, University of Wisconsin, Madison, United States*

**B9.2** 08:40
A Compact Multi-Resonant SIW Cavity-Backed Slot Antenna with Unprecedented Wideband Performance
*Aditya Varma Muppala, Kamal Sarabandi, University of Michigan, Ann Arbor, United States*

**B9.3** 09:00
Wideband Circularly Polarized Array Using Tightly Coupled Dipole Array Theory
*Muhammad Mubasshir Hossain, Stavros Koulouridis, Satheesh Bojja Venkatakrishnan, John L. Volakis, Florida International University, United States*

**B9.4** 09:20
Reconfigurable Diode-Based and Liquid Metal Antenna for 5 GHz Wi-Fi
*Jonathan Lundquist, Lauren Linkous, Erdem Topsakal, Virginia Commonwealth University, United States*

**B9.5** 09:40
An Extremely Wideband 3-D Printed Compact Antenna for MIMO Applications
*Drasti Tandel, Satish Sharma, San Diego State University, United States*

Friday, January 12 | 10:00 - 10:20
Event | Engineering Center Main Lobby

## Break

Friday, January 12 | 10:20 - 11:40
A2 | Room 105

## Advances in Antenna Design

Session Co-Chairs: Elias A. Alwan, Florida International University; Andrea Schmidt, Los Alamos National Laboratory; Sima Noghanian, CommScope Ruckus Wireless Networks

**A2.1** 10:20
Conformal, Compact and Low-profile Antenna for Medical Body Area Network Applications
*Mohammad Hashmi, Nazarbayev University, Kazakhstan; Dinesh Rano, Birla Institute of Technology and Science, India*

**A2.2** 10:40
Design of Pentaband Antenna with High Frequency Ratio for CubeSat Applications
*Md Nazim Uddin, Elias A. Alwan, Florida International University, United States*

**A2.3** 11:00
A Practical Superluminal Polarization Current Antenna: Theory, Design, and Construction
*Andrea Schmidt, John Singleton, Los Alamos National Laboratory, United States*

**A2.4** 11:20
Efficient 15 GHz Antenna Based on a Miniature 5G Wireless Communication Antenna
*Joselyn Contardi, Abas Sabouni, Wilkes University, United States*

Friday, January 12 | 10:20 - 11:40
E2 | Special Session | Room 150

## History and Future of USNC Commission E

Session Co-Chairs: Jane Lehr, University of New Mexico; Charles Dietlein, NTIA

**E2.1** 10:20
Trends in Commission E in National Radio Science Meetings
*Robert Gardner, Consultant, United States; Leigh Gardner, London School of Economics and Political Science, United States*

**E2.2** 10:40
Cyclostationary Channel Power Measurements for CBRS Coexistence Assessment
*Daniel Kuester, NIST, United States; Anthony Romaniello, Peter Mathys, NTIA, United States*

**E2.3** 11:00
An Analysis of Low-Cost SDRs to Meet City-Wide Spectrum Utilization Measurement Requirements
*AJ Cuddeback, CU Boulder, Institute for Telecommunication Sciences, United States; Scott Palo, CU Boulder, United States; Philip Erickson, MIT Haystack Observatory, United States*

**E2.4** 11:20
Modeling 5G Interference on a Weather Radiometer
*Ryan Murray, J. Nicholas Laneman, University of Notre Dame, United States*

Friday, January 12 | 10:20 - 11:20
B10 | Special Session | Room 151

## Antennas for Planetary Exploration

Session Co-Chairs: Avinash Sharma, The Johns Hopkins University Applied Physics Laboratory; Katherine Wolff, The Johns Hopkins University Applied Physics Laboratory

**B10.1** 10:20
NASA Dragonfly Lander Low Gain Antenna Design, Fabrication, and Testing
*Katherine Wolff, Johns Hopkins University Applied Physics Laboratory, United States*

**B10.2** 10:40
Satellite Ka-Band additive manufactured antenna
*Avinash Sharma, Jeffrey Valenti, Alan Githens, Katherine Wolff, Valerie Lehmann, The Johns Hopkins University Applied Physics Laboratory, United States*

**B10.3** 11:00
High Power Microwave Effects in Antennas for Planetary Exploration
*Avinash Sharma, The Johns Hopkins University Applied Physics Laboratory, United States*

Friday, January 12 | 12:10 - 13:00
Event | Math 100

## Eleventh Hans Liebe Lecture

Friday, January 12 | 13:10 - 15:10
A3 | Room 105

### Advances in Electromagnetic Measurements: Antennas and Beyond

Session Co-Chairs: Ryan Green, Mississippi State University; Mustafa Aksoy, University at Albany,State University of New York; Ahmed M. Hassan, University of Missouri, Kansas City; Matthew Simons, NIST

**A3.1** **13:10**
Direction-of-Arrival Estimation Using A Uniform Linear Array Considering Antenna Radiation Patterns
*Kai Ren, South Dakota School of Mines and Technology, United States*

**A3.2** **13:30**
Comparison of Antenna parameters acquired in the reactive nearfield, radiating nearfield (Fresnel), and far-field (Fraunhofer) regions
*William Dykeman, Ryan Green, Junming Diao, Mississippi State University, United States*

**A3.3** **13:50**
Optimizing Antenna Element Distribution for Enhanced Gain in Sparse Array Configurations
*Michael Ortiz, Elias Alwan, Florida International University, United States*

**A3.4** **14:10**
Different Geometrical Representations of Partially Reflected Surfaces for Fabry-Perot Antenna Optimization
*Mashrur Zawad, University of Missouri, Kansas City, United States; Mohamed Z. M. Hamdalla, Missouri Institute for Defense and Energy (MIDE), United States; Ahmed M. Hassan, University of Missouri, Kansas City, United States*

**A3.5** **14:30**
Revisiting the Water Permittivity: 0-50 GHz Measurements at Temperatures up to 50ºC
*Rahul Kar, Mustafa Aksoy, University at Albany,State University of New York, United States*

**A3.6** **14:50**
Statistical Electrical Effect Detection
*Doug Drake, Ahmed Hassan, Alex Pusateri, Stephan Young, University of Missouri - Kansas City, United States*

Friday, January 12 | 13:10 - 15:10
C2 | Room 150

### Advances in Software Defined and Adaptive Radio Systems

Session Co-Chairs: John L. Volakis, Florida International University; Danilo Erricolo, University of Illinois Chicago; Jonathan Chisum, University of Notre Dame

**C2.1** **13:10**
Bridging the Digital Divide in Rural America with Superluminal Polarization Current Technology
*John Singleton, Andrea Schmidt, Los Alamos National Laboratory, United States*

**C2.2** **13:30**
Multi-Mode Array Feed Operations with the Westford Radio Telescope
*Daniel Sheen, Frank Lind, Massachusetts Institute of Technology, United States*

**C2.3** **13:50**
Direct-RF Full Duplex Radio With 22-dB/200-MHz Digital Self-Interference Cancellation
*Kefayet Ullah, Satheesh Bojja Venkatakrishnan, John L. Volakis, Florida International University, United States*

**C2.4** **14:10**
Discrete-time synchronization for narrow-band signals
*Michael Baram, Jonathan Chisum, University of Notre Dame, United States*

**C2.5** **14:30**
Near-Field MIMO RIS Channel Capacity
*Tamara Abou El Hessen, Danilo Erricolo, Daniela Tuninetti, University of Illinois Chicago, United States*

**C2.6** **14:50**
Digital Twin Models to Enable Design Optimization of Ultra-Wide Band Transceiver Systems
*Arnaldo Sans, John Willis, John Volakis, Satheesh Venkatakrishnan, Florida International University, United States; Wilfredo Rivas-Torres, Keysight Technologies, Inc., United States*

Friday, January 12 | 13:10 - 14:50
B11 | Room 151

### Theory, Materials, and Devices

Session Co-Chairs: Michael Havrilla, Air Force Institute of Technology; Kubilay Sertel, The Ohio State University; John L. Volakis, Florida International University

**B11.1** **13:10**
Pure Magnetic Dipole Radiation Resulting from Spherical Electric Current Density by Use of Spherical Harmonics
*David Garren, Naval Postgraduate School, United States*

**B11.2** **13:30**
Statistics of Electromagnetic Fields Excited in a Finite Length Cylindrical Cavity Under Longitudinal Aperture Position Uncertainties
*Secil E. Dogan, Joel T. Johnson, Robert J. Burkholder, The Ohio State University, United States*

**B11.3** **13:50**
Bianisotropic Material Characterization using a Rectangular-to-Square Waveguide
*Moriel Gindi, Michael Havrilla, Air Force Institute of Technology, United States*

**B11.4** **14:10**
Battery-less and Wireless Neurosensing System for Monitoring of Neuronal Activity in Swine
*Melany Gutierrez-Hernandez, Satheesh Bojja-Venkatakrishnan, Sally Duarte, Jorge Riera Diaz, John L. Volakis, Florida International University, United States*

**B11.5** **14:30**
Link Budget Analysis of Interrogation of Surface Acoustic Wave Sensors in Metallic Tubular Structures
*Richard Pingree, Jagannath Devkota, Leidos c/o NETL, United States; Ruishu Wright, National Energy Technology Laboratory, United States*

Friday, January 12 | 13:10 - 14:50
H5 | Special Session | Room 155

### Heliospheric Observations of Waves in Plasmas

Session Co-Chairs: David Malaspina, University of Colorado, Boulder; Hassanali Akbari, NASA Goddard Space Flight Center

**H5.1** **13:10**
Non-lightning-generated whistler waves in near-Venus space
*Harriet George, David Malaspina, Laboratory for Atmospheric and Space Physics, University of Colorado Boulder, United States; Katy Goodrich, West Virginia University, United States; Yingjuan Ma, University of California Los Angeles, United States; Robin Ramstad, Laboratory for Atmospheric and Space Physics, University of Colorado Boulder, United States; Dylan Conner, West Virginia University, United States; Stuart Bale, Shannon Curry, Space Sciences Laboratory, University of California, Berkele, United States*

**H5.2** **13:30**
Statistics on Whistler Waves Propagation Direction from Parker Solar Probe Observation
*Kyung-Eun Choi, Oleksiy Agapitov, Space Sciences Laboratory, University of California Berkeley, United States*

**H5.3** **13:50**
Turbulently Generated Kinetic Alfvén Wave Power Associated with Switchbacks in the Near-Sun Solar Wind
*Peter Tatum, David Malaspina, Laboratory for Atmospheric and Space Physics, United States*

**H5.4** **14:10**
A series of small-scale magnetic flux ropes originating from the narrow longitudinal and latitudinal region identified in co-rotating observation of Parker Solar Probe
*Kyung-Eun Choi, Space Sciences Laboratory, University of California Berkeley, United States; Dae-Young Lee, Chungbuk National University, Korea (South); Katsuhide Marubashi, National Institute of Information and Communications Technology, Japan; Sung Jun Noh, Los Alamos National Laboratory, United States; Oleksiy Agapitov, Space Sciences Laboratory, University of California Berkeley, United States*

**H5.5** **14:30**
Patterns and Properties of Ion Cyclotron Waves around Venus
*Delaney Lee-Bellows, David Malaspina, Harriet George, Peter Tatum, Laboratory for Atmospheric and Space Physics, United States*

Friday, January 12 13:10 - 15:10
GH4 Special Session Room 200

## Machine Learning Techniques for Near Earth Space Science

Session Co-Chairs: Vijay Harid, UC Denver; Xiangning Chu, Laboratory for Atmospheric and Space Physics, University of Colorado Boulder, Boulder, Colorado, USA

**GH4.1** **13:10**
Space Weather modeling at the University of Colorado Deep Learning Laboratory
*Enrico Camporeale, A. Hu, G. Lucas, J. Knuth, T. Berger, University of Colorado, United States*

**GH4.2** **13:30**
Global Electron Precipitation Driven by Whistler Mode Waves Using a Combination of Deep Learning and Physics-based Models
*Sheng Huang, Wen Li, Qianli Ma, Xiao-Chen Shen, Luisa Capannolo, Boston University, United States; Xiangning Chu, University of Colorado Boulder, United States*

**GH4.3** **13:50**
Distribution and evolution of chorus waves modeled by a neural network: the importance of imbalanced regression
*Xiangning Chu, Laboratory for Atmospheric and Space Physics, University of Colorado Boulder, Boulder, Colorado, USA, United States; Jacob Bortnik, Department of Atmospheric and Oceanic Sciences, University of California, Los Angeles, California, USA, United States; Wen Li, Xiao-Chen Shen, Qianli Ma, Center for Space Physics, Boston University, Boston, Massachusetts, USA, United States; Donglai Ma, Department of Atmospheric and Oceanic Sciences, University of California, Los Angeles, California, USA, United States; David Malaspina, Laboratory for Atmospheric and Space Physics, University of Colorado Boulder, Boulder, Colorado, USA, United States; Sheng Huang, Center for Space Physics, Boston University, Boston, Massachusetts, USA, United States*

**GH4.4** **14:10**
Forecasting Global VTEC data from VISTA with High Spatial and Temporal Resolution Using Transformer-Based Deep Learning Model
*Srivani Inturi, Mark Golkowski, University of Colorado Denver, United States*

**GH4.5** **14:30**
The Response of Ionospheric Currents to External Drivers Investigated Using a Neural Network-Based Model
*Xin Cao, Xiangning Chu, University of Colorado Boulder, United States; Jacob Bortnik, James Weygand, Jinxing Li, Homayon Aryan, Donglai Ma, UCLA, United States*

**GH4.6** **14:50**
Neural Network-based classification of polar cap and auroral scintillations in high latitude regions as a function of geomagnetic activity
*Kshitija Deshpande, Embry Riddle Aeronautical University, United States; Ishaan Dey, Nicolas Gachancipa, Chintan Thakrar, ERAU, United States*

Friday, January 12 13:10 - 16:10
F5 Room 245

## Microwave Remote Sensing of the Earth

Session Co-Chairs: Mehmet Ogut, JPL; Thomas Hanley, Johns Hopkins University Applied Physics Laboratory

**F5.1** **13:10**
Microwave Photonic Ultra-Wideband Radiometer For Planetary Boundary Layer Sensing
*Mehmet Ogut, Shannon Brown, Sidharth Misra, Eric Kittlaus, Pekka Kangaslahti, JPL, United States; Janusz Murakowski, Phase Sensitive Innovations, United States; Michael Gehl, Sandia National Laboratories, United States*

**F5.2** **13:30**
P- and L-band Retrieval of Root-zone Soil Moisture and Temperature Profiles as Quadratic Function
*Ming Li, Roger Lang, The George Washington University, United States*

**F5.3** **13:50**
Soil Moisture During 2015 Spring Flood Events from the SMAP Radar Time-Series Ratio Algorithm
*Dustin Horton, Joel Johnson, Mohammad Al-Khaldi, The Ohio State University, United States; Ismail Baris, German Aerospace Center, Germany; Jeonghwan Park, Rajat Bindlish, NASA Goddard Space Flight Center, United States*

**F5.4** **14:10**
Improving a machine learning model for satellite precipitation downscaling
*Yongxin Liu, Haonan Chen, Colorado State University, United States*

**F5.5** **14:30**
Radar Partial Beam Blockage Correction for Improving Precipitation Mapping
*Songjian Tan, Haonan Chen, Colorado State University, United States*

**Break** **14:50**

**F5.6** **15:10**
Winter Event Observations at Wallops Flight Facility in 2022 and Ongoing Analyses of Collected Data
*Hein Thant, V. N. Bringi, Branislav Notaros, Colorado State University, United States*

**F5.7** **15:30**
Investigating the Relationship Between Lightning and GNSS Signal Disturbances
*Karthik Kolipaka, Ishaan Dey, Pavel Inchin, Christopher Heale, Björn Bergsson, Embry-Riddle Aeronautical University, United States; Steve Cummer, Duke University, United States; Kshitija Deshpande, Embry-Riddle Aeronautical University, United States*

**F5.8** **15:50**
Spectral Calibration of the Electrojet Zeeman Imaging Explorer – Microwave Electrojet Magnetogram Polarimetric Radiometer System
*Sidharth Misra, Sharmila Padmanabhan, Pekka Kangaslahti, JPL, CalTech, United States; Jeng-Hwa Yee, JHU, APL, United States*

Friday, January 12 13:10 - 15:10
J6 Special Session Room 265

## CHIME/FRB Outriggers I

Session Co-Chairs: Aaron Pearlman, McGill University; Pranav Sanghavi, Yale University

**J6.1** **13:10**
The CHIME/FRB Outrigger Program
*Adam Lanman, Massachusetts Institute of Technology, United States*

**J6.2** **13:30**
Characterizing the Performance of the First CHIME/FRB Outrigger as a Standalone Interferometer
*Mattias Lazda, University of Toronto, Canada*

**J6.3** **13:50**
CHIME/FRB Outriggers: Removing Systematic Baseline Delays Using Traditional VLBI Continuum Sources
*Mattias Lazda, University of Toronto, Canada*

**J6.4** **14:10**
Removing Clock-Drift and Ionospheric Errors from the CHIME-KKO VLBI Delays
*Vishwangi Shah, McGill University, Canada*

**J6.5** **14:30**
pycalc11: A Python Interface to the CALC VLBI Delay Model
*Adam Lanman, Massachusetts Institute of Technology, United States; Marten van Kerkwijk, University of Toronto, Canada*

**J6.6** **14:50**
Arcsecond localizations with the first CHIME-Outriggers Telescope
*Shion Andrew, MIT Kavli Institute for Astrophysics and Space Research, United States*

Friday, January 12 13:10 - 15:10
D5 Special Session Room 1B40

## Recent Advances in Reconfigurable Intelligent Surfaces

Session Co-Chairs: Jonathan Chisum, University of Notre Dame; Cody Scarborough, University of Colorado at Boulder

**D5.1** 13:10
Network-based Design of Reconfigurable Intelligent Surfaces
*Malik Almunif, Anthony Grbic, University of Michigan, United States*

**D5.2** 13:30
Digitally-modulated OOK Reconfigurable Intelligent Surfaces for Massively-scalable Gbps Transmitters
*Himanshu Sharma, Xiangbo Meng, Nicholas Laneman, University of Notre Dame, United States; Ralf Bendlin, AT&T, United States; Bertrand Hochwald, Jonathan Chisum, University of Notre Dame, United States*

**D5.3** 13:50
1-Bit, Wideband mmWave Phase Shifter for Reconfigurable Intelligent Surfaces with Minimum Phase Errors
*Tatiana Valera, Stavros Koulouridis, Arjuna Madanayake, Satheesh Venkatakrishnan, John Volakis, Florida International University, United States*

**D5.4** 14:10
Liquid-Metal-Based Reconfigurable Intelligent Surfaces
*Wayne Shiroma, Aaron Ohta, Saige Dacuycuy, Glan Allan Manio, Matthew Kouchi, Keith Maki, University of Hawaii at Manoa, United States*

**D5.5** 14:30
Loading Rims of Radio Telescopes with Reconfigurable Reflectarrays for Adaptive Null-Steering
*Jordan Budhu, Virginia Tech, United States; Sean V. Hum, University of Toronto, Canada; Steven Ellingson, R. Michael Buehrer, Virginia Tech, United States*

**D5.6** 14:50
Compact, Low-Dispersion, Metalo-Dielectric Gradient-Index Lenses with Additive Manufacturing
*Benjamin Davis, Jonathan Chisum, University of Notre Dame, United States*

Friday, January 12 15:10 - 15:30
Event Engineering Center Main Lobby

## Break

Friday, January 12 15:30 - 17:30
B12 Room 151

## Numerical Methods

Session Co-Chairs: Fernando Teixeira, The Ohio State University; Erdem Topsakal, VCU; Yahya Rahmat-Samii, UCLA

**B12.1** 15:30
Particle Trajectory Error in Finite Element Particle-in-Cell Kinetic Plasma Simulation
*Haitham Saleh, Fernando Teixeira, The Ohio State University, United States*

**B12.2** 15:50
Machine Learning Assisted Optimization Methods for Automated Antenna Design
*Lauren Linkous, Erdem Topsakal, VCU, United States*

**B12.3** 16:10
Adaptive Solution Space in Particle Swarm Optimization
*Sahar Bagherkhani, University of California, Irvine, United States; Yahya Rahmat-Samii, University of California, Los Angeles, United States; Franco De Flaviis, University of California, Irvine, United States*

**B12.4** 16:30
Predicting Ionic Conductivity of Solid-State Battery Cathodes Using Machine Learning
*Mai Le, University of Houston, United States; Hieu Le, Texas A&M, United States; Jiefu Chen, Xuqing Wu, Yan Yao, University of Houston, United States*

**B12.5** 16:50
Accuracy and Convergence Studies of Surrogate Methods for Uncertainty Quantification in FEM Scattering Computations
*Branislav Notaros, Stephen Kasdorf, Colorado State University, United States*

**B12.6** 17:10
CGFFT Iterative Solver of Integral Equations Launched on a Neural Network Platform
*Botian Zhang, Yahya Rahmat-Samii, UCLA, United States*

Friday, January 12 15:30 - 16:50
H6 Room 155

## Heliospheric Plasma Processes

Session Co-Chairs: Chris Crabtree, US Naval Research Laboratory; Ami DuBois, US Naval Research Laboratory

**H6.1** 15:30
Wave Vector of H+ Band EMIC Waves and Corresponding Electron Resonance Energy Determinations by 4 MMS Satellites
*Xu Liu, University of Texas at Dallas, United States; Lunjin Chen, The University of Texas at Dallas, United States*

**H6.2** 15:50
Lower-hybrid waves and Nonlinear Whistler wave generation in Solar Flares
*A. Rualdo Soto-Chavez, Chris Crabtree, Guru Ganguli, Alex C. Fletcher, US Naval Research Laboratory, United States*

**H6.3** 16:10
First Direct Radiation Resistance Measurement on a Loop Dipole Antenna from Excitation of Whistler Waves
*Seth Dorfman, Space Science Institute, United States; Troy Carter, UCLA, United States; Quinn Marksteiner, Los Alamos National Laboratory, United States; Patrick Pribyl, UCLA, United States; Gian Luca Delzanno, Los Alamos National Laboratory, United States*

**H6.4** 16:30
Modulation of Interstellar Dust by Solar Rotation Inside Heliosphere
*Shivank Chadda, University of Colorado, Boulder, United States*

Friday, January 12 15:30 - 17:30
G5 Room 200

## Radar and Radio Techniques for Ionospheric Diagnostics

Session Co-Chairs: Thomas Gaussiran, The University of Texas at Austin; Joseph Helmboldt, U.S. Naval Research Laboratory; Sam Shidler, The University of Texas at Austin

**G5.1** 15:30
EclipseNB: A Radio Instrument Network for Monitoring the Ionosphere During the April 8, 2024 Total Solar Eclipse
*Chris Watson, Anton Kashcheyev, Thayyil Jayachandran, Richard Chadwick, University of New Brunswick, Canada*

**G5.2** 15:50
Improvements to GNSS-based Ionospheric Monitoring using Low-Elevation Single-Frequency Wideband Signals
*Madeline Evans, Yang Wang, Brian Breitsch, Jade Morton, University of Colorado Boulder, United States*

**G5.3** 16:10
Simultaneous Measurements of Temporal and Spatial Phase Structure Functions of an HF Skywave Signal at Mid-Latitudes
*Joseph Helmboldt, U.S. Naval Research Laboratory, United States*

**G5.4** 16:30
Climatology of Equatorial F-Region UHF Coherent Backscatter Radar Echoes and Comparison with Collocated VHF Radar Observations
*Alexander Massoud, Fabiano Rodrigues, Jonas Sousasantos, The University of Texas at Dallas, United States; Marco Milla, Pontificia Universidad Católica del Perú, Peru; Danny Scipion, Joab Apaza, Karim Kuyeng, Radio Observatorio de Jicamarca, Instituto Geofísico del Perú, Peru; Carlos Padin, Universidad Ana G. Méndez, United States*

**G5.5** 16:50
A Modern VLF Receiver for use in an Array for VLF Imaging of the D-Region
*James Cannon, Robert Marshall, Ryan Dick, Bennett Fragomeni, Sebastian Wankmueller, Sophia Orlandella, University of Colorado Boulder, United States*

**G5.6** 17:10
Augmenting the observational capabilities of the Jicamarca Radio Observatory with LWA stations
*Fabiano Rodrigues, UT Dallas, United States*

Friday, January 12 15:30 - 17:30
J7 Special Session Room 265

## CHIME/FRB Outriggers II

Session Co-Chairs: Aaron Pearlman, McGill University; Pranav Sanghavi, Yale University

**J7.1** **15:30**
Green Bank CHIME/FRB Outriggers Overview and Current Status
*KHOLOUD KHAIRY, West Virginia University, United States*

**J7.2** **15:50**
Commissioning the CHIME outrigger telescope at Green Bank : N2 diagnostics
*Arvind Balasubramanian, Tata Institute of Fundamental Research, India; Bridget Andersen, McGill University, Canada; Kevin Bandura, West Virginia University, United States; Adam Lanman, Kenzie Nimmo, Massachusetts Institute of Technology, United States*

**J7.3** **16:10**
Commissioning Status of the Green Bank CHIME/FRB Outrigger
*Bridget Andersen, McGill University, Canada*

**J7.4** **16:30**
A VLBI Calibration System with Real-time Pulsar Gating for FRB Localization using CHIME/FRB Outriggers
*Aaron B. Pearlman, McGill University; Trottier Space Institute at McGill University, Canada*

**J7.5** **16:50**
PyFX: software correlator for wide-field VLBI with CHIME/FRB Outriggers
*Shion Andrew, MIT Kavli Institute for Astrophysics and Space Research,, United States*

**J7.6** **17:10**
LPDA Arrays for Localising Bright Nearby FRBs from CHIME sidelobes
*Nina Gusinskaia, UNIVERSITY OF TORONTO, Canada*

Friday, January 12 15:30 - 17:30
B13 Special Session Room 1B40

## Complex EM and Meta Structures

Session Co-Chairs: Juan Sebastian Gomez Diaz, University of California, Davis; Filippo Capolino, University of California, Irvine

**B13.1** **15:30**
Space-Time Nonlocal Metasurfaces for Event-Based Image Processing
*Sedigheh Esfahani, Michele Cotrufo, Andrea Alu, City University of New York, United States*

**B13.2** **15:50**
Signal compression with waves
*Dimitrios Sounas, Wayne State University, United States*

**B13.3** **16:10**
Terahertz Faraday Rotation based on Optically Pumped Graphene Coupled to Surface Lattice Resonances
*Damia Casas i Casajuana, Juan Sebastian Gomez Diaz, University of California, Davis, United States*

**B13.4** **16:30**
Electromagnetic Wave Propagation and Amplification in Anisotropic Material Made of Stacking Layers of Two-dimensional Material and Dielectric
*Amin Hakimi, Kasra Rouhi, Filippo Capolino, University of California, Irvine, United States*

**B13.5** **16:50**
High Performance and Spectrally Selective IR Sensing Based on Integrating MEMS and Metasurfaces
*Melisa Gulseren, Matthew Benson, Ryan Parker, Arnau Fite Cluet, Zhixing Lin, Juan Sebastian Gomez Diaz, University of California, Davis, United States*

**B13.6** **17:10**
Subwavelength-Structured Waveguides for Free-Electron-Photon Interactions
*Omer Emre Ates, Benjamin Slayton, William Putnam, University of California, Davis, United States*

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