

Guest Editorial

The Eighteenth Special Issue on High-Power Microwave and Millimeter-Wave Generation

THE field of high-power microwave and millimeter-wave generation continues to be an active area of research and technological development to meet the demand of high peak, average, and prime power needs of government and industrial applications. High-power vacuum electronic devices, producing coherent electromagnetic radiation ranging from tens of centimeters to submillimeter wavelengths, continue to find application in advanced fusion and accelerator device applications, state-of-the-art radar and electronic countermeasures, high data-rate communications, and material processing. Advances in materials, plasmas, cathode technology, and electromagnetic structure design, as well as theory, modeling, and simulation, help to drive this technology to achieve unprecedented peak and average power, more compact size, enhanced waveform agility, greater bandwidth, and higher efficiency.

The Eighteenth Special Issue on High-Power Microwave and Millimeter-Wave Generation continues the important heritage of the past Special Issues on High-Power Microwave Generation; however, in response to growing interest in higher frequency regimes [item 1) in the Appendix], millimeter waves are now explicitly included in the issue title. The present Special Issue is organized into five general topics areas, including high-power electromagnetic source technology, microwave and millimeter-wave amplifiers, multipactor physics, space charge and wave-plasma interactions, and novel ferrite devices and high-voltage materials.

The high-power electromagnetic source technology papers, representing 33.3% of the Special Issue contributions, start with an overview by Selemir *et al.* of key achievements in virtual cathode microwave sources at the Russian Federal Nuclear Center (RFNC-VNIEF). Studies on multifrequency output of novel recirculating planar magnetrons are provided by Packard *et al.* and Chen *et al.* investigate improvements to the performance of phase-locked magnetrons. Simulation studies on high-power sources include a particle-in-cell analysis of an MW-class, 28-vane, X-band magnetron by Joshi *et al.* and an analysis of a GW-Class MILO using both particle-in-cell and frequency domain electromagnetic methods by Packard *et al.* Finally, research on a coaxial, multibeam, extended-interaction oscillator is described by Zhang *et al.*

The first Special Issue amplifier paper by Wu, *et al.* describes a pseudoperiodic helix traveling wave tube (TWT). Next, Exelby *et al.* discuss results from a high power

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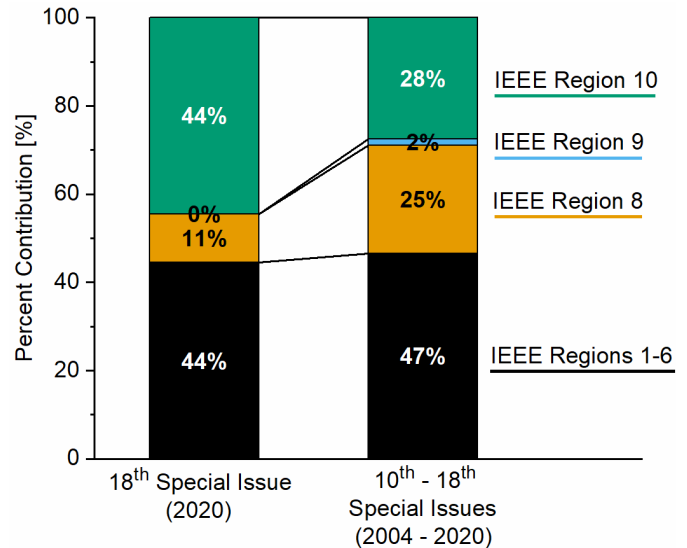


Fig. 1. Comparison of Special Issue contributions from IEEE Regions.

crossed-field amplifier based on the recirculating planar magnetron topology. This is followed by a study from Zhou, *et al.* on relativistic triaxial klystrons. At higher frequencies, a millimeter wave gyro-TWT with multi-stage depressed collector is presented by Thottappan, *et al.* The final amplifier paper, by Bai, *et al.* regards a THz TWT, based on a defect photonic crystal waveguide. The Guest Editors note that 26.3% of the present Special Issues pertain to the amplification of high frequency waveforms.

The three Special Issue papers on multipactor physics, representing 16.7% of the overall Special Issue contributions, are aligned with the ongoing multidisciplinary university research initiative (MURI) titled “Multipactor and Breakdown Susceptibility and Mitigation in Space-Based RF Systems.” The science of multipactor discharges remains as an impactful topic area for technical fields such as RF satellite communications, particle accelerators, and high-power microwave system development. The first multipactor paper by Langellotti *et al.* includes the development of numerical models for multipactor in coaxial geometries and comparisons of these models with experiments. Next, Iqbal *et al.* describe efforts to understand single-surface multipactor discharges initiated in multitone RF electric fields. Finally, Wong *et al.* describe RF harmonic generation in multipactor discharges.

In the Special Issue penultimate topic area of space charge effects and wave-plasma interactions (16.7% of the

Special Issue contributions), Haraldsson *et al.* present work on modeling of space-charge effects developed between planar field emitters. Reid *et al.* provide an article on plasma discharge modes observed in focused high-power microwave beams. Janicek *et al.* describe advances in the understanding of the dependence of plasma channel length on microwave emission spectra, as related to using optical wavelengths to drive microwave generation in atmospheric plasmas.

The final topic area, comprising 11.1% of the Special Issue, includes advances in novel ferrite devices and high-voltage materials. A paper by Franzi *et al.* provides insight on a new class of high-power, nonreciprocal, ferrite-based, RF devices which use highly compact microwave polarizers to control microwave power flow. The final Special Issue paper, presented by Zhao *et al.* details investigations into extending lifetimes of high-voltage insulators used in HPM systems.

A comparison of IEEE regions contributing to the present Special Issue is provided in Figure 1. Also shown is the same comparison for all 198 technical papers comprising Special Issues 10 through 18. Majority contributors for IEEE Region 8 (Africa, Europe, and Middle East), IEEE Region 9 (Latin America), and IEEE Region 10 (Asia and Pacific) are Russia, Brazil, and China, respectively. Russia accounts for 40.8% of all Region 8 Special Issue papers for the 2004–2020 time period, and China accounts for 52.7% of all Special Issue papers for Region 10 for the same time period. All Special Issue papers received from Region 9 originated from Brazil. For the 2004–2020 time period, no Special Issue contributions originated from IEEE Region 7 (Canada).

In closing, the Guest Editors note that the preparations and release of the Eighteenth Special Issue are occurring during the COVID-19 pandemic. We sincerely thank the Editorial Staff, Reviewers, and Authors for their critical contributions and

perseverance in challenging working conditions and hope that you and your families, friends, and colleagues are staying safe during these uncertain times.

APPENDIX RELATED WORK

- 1) J. Luginsland, J. Sirigiri, and J. Yater, "Guest editorial special issue on plenary, invited, and selected minicourse tutorial papers from ICOPS 2018," *IEEE Trans. Plasma Sci.*, vol. 47, no. 5, p. 1993, May 2019, doi: [10.1109/TPS.2019.2911843](https://doi.org/10.1109/TPS.2019.2911843).

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