Guest Editorial
The Twelfth Special Issue on High-Power Microwave Generation

THE TWELFTH Special Issue on High-Power Microwave (HPM) Generation continues the custom of placing the spotlight on HPM sources driven by intense electron beams, where the resulting power density provides significant and unique research challenges relative to traditional vacuum electronics sources. In addition, the Special Issue documents the supporting hardware and computational technology developments that push forward the state of the art in high power sources of coherent electromagnetic (EM) radiation. These biannual special issues offer an opportunity to gain perspective on the field and note the trends of the subject as a whole. While millimeter-wave devices have been a common topic since the beginning of the Special Issues [1], the movement toward higher frequency sources, into the terahertz range, is evident in Fig. 1. Furthermore, in keeping with recent special issues, it is evident that the community is dedicating more effort to increasing the output power through novel beam/wave interactions rather than focusing exclusively on the challenge of pulse shortening. Interestingly, in this Special Issue, no articles are dedicated to pulse shortening, in stark contrast to ten years ago [2]. Moreover, there has been a significant increase in articles related to electron beam formation and transportation, which is the lifeline of an HPM device. Also, the recent interest in sheet beam and multiple beam devices has resulted in significant research on this topic. The current special issue has about 15% of articles devoted to this area compared to about 3% in all the previous Special Issues.

The 12th issue continues the wide-ranging distribution of subject matter. As noted in Table I, gyro and slow-wave devices continue the tradition of providing the bulk of the articles dealing with source technology. Similarly, we have a very even distribution of source articles spread out among klystrons, vircators, plasma devices, and magnetrons. Perhaps most interesting, however, is the continuing increase in articles detailing research of ancillary equipment in the supporting technology, computing, and beam formation areas, as noted earlier. This would seem to suggest that along with the evolution to higher frequency, the HPM community is focusing on enabling technology, including cathodes, collectors, antennas, materials, and computational models to support these new high-frequency design requirements.

This Special Issue organizes its articles by applications, sources (including experimental, computational, and theoretical contributions), and enabling technology. The issue starts with a review of novel uses of HPM in supporting space applications by Benford. Next, Fliflet *et al.* offer a view of material processing via a coupled electrodynamic–thermal analysis of a ceramic cylinder loaded by a millimeter-wave beam. These articles offer new vistas for the application of coherent EM radiation, beyond the established functions of radar and communication equipment. From this first course, we return to the traditional leader in number of articles, gyro-devices. We start with the development of high-frequency harmonic gyrotrons operating in hundreds of gigahertz by Glyavin *et al.* This is followed by the observations of mode competition in an X-band magnicon amplifier by Gold *et al.* The next two articles detail enabling technology: Coaxial gyrotrons are strong contenders for producing high power in the millimeter wave regime. Accurate modeling of the beam-wave interaction in such highly overmoded devices is very challenging and is the topic of the article by Vlasov *et al.* The current status of thermionic cathodes in the gyro-device context and novel ideas for improving their emission and lifetime are the subject of the article by Ives *et al.* Finally, we close this section with the details of RF behavior in a continuous wave gyrotron for plasma heating by Machavaram *et al.*

In the arena of slow-wave and superradiative devices, we continue the evolution to high-frequency operation with a study of self-fields in the planar orotron by Yu *et al.* Next, we see the potential to use the guide magnetic field to achieve amplification in traveling wave tubes (TWTs) driven by intense beams by Fuks *et al.* This is followed by two articles dealing with very short-pulse, high rep-rate HPM sources by Rostov *et al.* and Klimov *et al.*

Klystron technology starts with the design of a beam forming system for a sheet beam klystron suitable for a high-frequency operation by Wang *et al.* The article by Chernyavskiy *et al.* detailing the development of the parallel simulation tool TESLA for multibeam klystrons follows. This section closes with the impact of high input power drivers on relativistic klystrons by Wei *et al.*

Elfsberg *et al.* start out the vircator and plasma device section with an article on the impact of cathode and anode materials in a rep-rated device. This is followed by the simulation study of secondary virtual cathode formation in low-voltage vircators by Singh *et al.* Bliokh *et al.* close this section by detailing the impact of ion noise in a plasma-assisted slow-wave device.

Hoff *et al.* provide a contribution on the role of a novel magnetic field configuration to prime the π mode in the relativistic magnetron.

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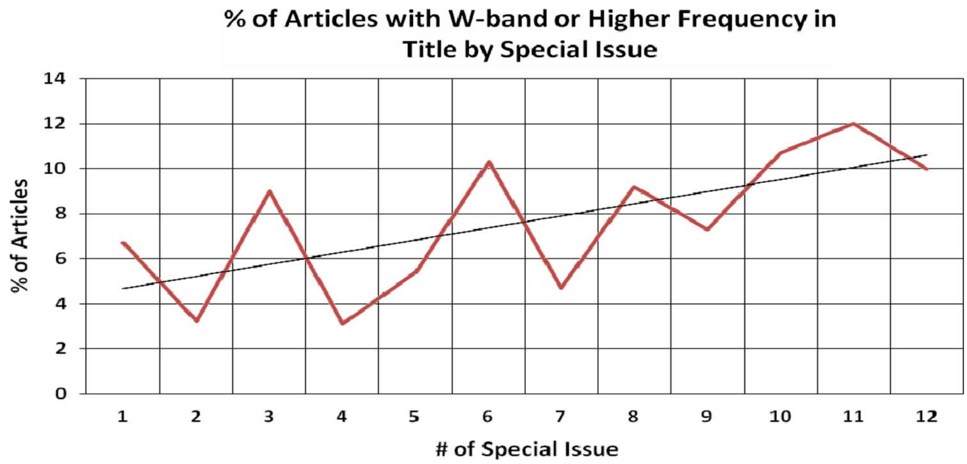

Fig. 1. Percentage of articles with W-band or higher frequency denoted in the title by special issue.

TABLE I
TOPICAL PAPERS BY PERCENTAGE IN THE SPECIAL ISSUE ON HPM GENERATION

Principle Subject	% of Issues 1-11	% of 12th Issue
Gyro-devices	36.29	20.00
BWO/TWT	14.93	15.00
Free-electron laser	7.75	5.00
Klystrons	7.56	5.00
Supporting technology	7.94	5.00
Cross-field devices	7.56	5.00
Plasma devices	4.54	5.00
Vircator	3.78	10.00
Computing techniques	3.21	10.00
Beam formation	3.21	15.00
Applications	1.51	5.00
Pulse shortening	1.13	0.00
Impulse devices	0.57	0.00

The 12th Special Issue ends with a section on cathodes and beam formation. Shiffler *et al.* provide a review of cathode research at the Air Force Research Laboratory. The issue closes with a multidimensional extension to space-charge limited flow for bunched beams in coaxial geometries by Hess.

Finally, we note with sadness the passing of Prof. Peter A. Lindsay, whose articles often graced the pages of the Bi-Annual Special Issues on HPM Generation. He was a leader in the international collaboration of HPM and vacuum electronics technology and an active ambassador of technical interchange. His physical insights, humor, and goodwill will be missed.

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REFERENCES

[1] A. Bensimhon *et al.*, “First experimental results on 100 Ghz 200 kW gyrotrons,” *IEEE Trans. Plasma Sci.*, vol. PS-13, no. 6, pp. 389–392, Dec. 1985.

[2] E. Schamiloglu and Y. Y. Lau, “The seventh special issue on high power microwave generation,” *IEEE Trans. Plasma Sci.*, vol. 26, no. 3, pp. 232–234, Jun. 1998.

John Luginsland received the B.S.E., M.S.E., and Ph.D. degrees in nuclear engineering (plasma physics option) from the University of Michigan, Ann Arbor, in 1992, 1994, and 1996, respectively.

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Joan Yater received the A.B. degree in physics from Cornell University, Ithaca, NY, in 1982, the M.S. degree in physics from the University of California, Santa Barbara, in 1986, and the Ph.D. degree in physics from the University of Texas, Austin, in 1992.

From 1993 to 1995, she was a National Research Council Research Associate with the Vacuum Electronics Branch, Electronics Science and Technology Division, Naval Research Laboratory (NRL), Washington, DC, where she has been a Research Physicist since 1995. Her research at NRL has focused on electron emission studies and cathode development for vacuum electronic device applications. She is involved in the research of novel cathode materials and concepts, including secondary emitters, cold emitters, and thermionic emitters and uses surface analytical and emission characterization techniques to identify the emission mechanisms and surface physics that govern the emission, stability, and lifetime properties of cathodes.