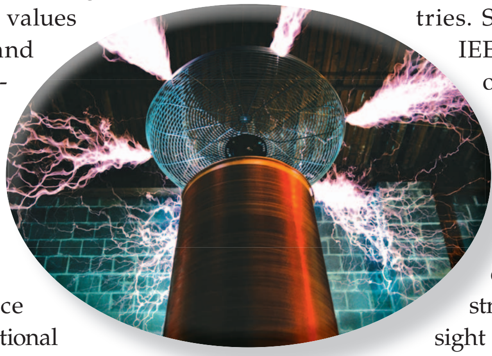
Backscatter

Exposure Limits

■ **Ralf Bodemann**

The article "Exposure Guidelines for Magnetic Resonance Imaging: The Most Successful Application of Electromagnetics in Biology and Medicine," by James C. Lin (*IEEE Microwave Magazine*, vol. 12, no. 4, pp. 45–46, June 2011) highlights the International Commission on Nonionizing Radiation Protection's (ICNIRP's) role in establishing limits for electromagnetic field (EMF) exposure during magnetic resonance imaging (MRI) procedures. The article provides useful information but does not tell the whole story regarding low-frequency exposure limits, specifically recognition of the work of the IEEE International Committee on Electromagnetic Safety (ICES) (Standards Coordinating Committee 39). In 2004, in an attempt to protect workers in the European Union, draft Directive 2004/40/EC [1] required that workplace exposures meet the 1998 ICNIRP exposure values. It was then discovered that compliance with the ICNIRP basic restrictions would preclude certain interventional MRI procedures (where the operator may be exposed to the same field intensities as is the patient), which created a need to examine the scientific basis and rationale for the ICNIRP values at low frequencies. In 2005, a member of ICES analyzed the large differences in the low frequency electric and magnetic field exposure values between ICES and ICNIRP and provided explanations of how the ICES limits were derived [2]. At that time, for example, the 1998 ICNIRP reference level for occupational magnetic field exposure at 1 kHz was 24.4 A/m [3] while the corresponding ICES value was 1,640 A/m [4]. The ICNIRP value was relaxed in 2010 and is now 240 A/m at 1 kHz [5].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The Lin article is incomplete in that there is no mention of the work of IEEE ICES, especially the significant work accomplished in the publication of the IEEE C95 series of standards (C95.1 was first published in 1966) addressing human exposure to electric, magnetic, and EM fields from 0 Hz to 300 GHz. ICES is an international committee with membership representing academia, federal public health and other government agencies, the military, and other users of electromagnetic energy and the product manufacturer communities. Currently the membership of the ICES committee and subcommittees that develop the exposure standards stands at 180 with members from 29 countries. Since the work of IEEE ICES is based on scientific review of the many sources of relevant data, an open consensus process, and operates under the strict rules and oversight of IEEE Standards Association, it seems incomplete to avoid mention of the IEEE ICES and its accomplishments. The IEEE ICES Web site is http://www.ices-emfsafety.org; a descriptive brochure can be found at http://www.ices-emfsafety.org/documents/publications/brochure_200704.pdf. IEEE C95 standards are now publicly available through the "IEEE Get Program" (http://standards.ieee.org/about/get/index.html).

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[1] Directive 2004/40/EC of the European Parliament and of the Council of 29 April 2004 on the

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Conclusion

Four examples have been chosen to demonstrate unique features and third-party libraries for use in microwave and RF engineering. The application areas of Python, however, are vast. The strong logical flow of the language makes it a perfect candidate for a variety of engineering tasks. Because of tremendous third-party library support, Python enables rapid application development (RAD). Some topics not included here, but very useful for microwave and RF engineering, are the database applications and GUI development. Interested readers should refer to the literature for more information on these topics [7]. Python comes essentially free-of-charge and with the support of thousands of enthusiastic users and experts around the world.

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