Foreword to the Special Issue on Scientific and Technological Progress of Synthetic Aperture Radar (SAR)

IT IS a pleasure to introduce this special issue of the IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING (TGRS), dedicated to the 9th European Conference on Synthetic Aperture Radar (EUSAR), which was held in Nürnberg, Germany, in April 2012. EUSAR is an international conference devoted to the technology and techniques of synthetic aperture radar (SAR). It was established in 1996 and organized biennially by the German Association for Electrical, Electronic and Information Technologies/Information Technology Society (VDE/ITG) in conjunction with Fraunhofer Institute for High Frequency Physics and Radar Techniques (FHR), German Aerospace Center (DLR), Cassidian, and EADS Astrium, and it is technically sponsored by the IEEE Geoscience and Remote Sensing Society (GRSS) and the IEEE Aerospace and Electronic Systems Society. Since its inception, worldwide interest in EUSAR has steadily increased as it provides an excellent forum for exchanging information and discussion on a wide variety of research topics representing the most recent SAR developments. While the first EUSAR featured two parallel sessions, the past conferences were partitioned into four parallel sessions. During EUSAR 2012, we had 40 sessions in three days of conference and a well-attended tutorial day prior the conference.

SAR offers a number of valuable features pertaining to earth observation, which cannot be achieved with optical sensors: day and night operation; penetration of weather, dust, and obscurants; geometric resolution independent of range; polarimetric detection and classification; 3-D imaging by interferometric techniques; and Doppler discrimination of moving targets. Typical applications include the generation of digital elevations maps (which is one part of TanDEM-X), observation of volcanic activities and flood disasters, land and sea traffic monitoring, observation of vegetation growth, monitoring of ocean currents and traveling icebergs, detection of oil spills on the ocean, reconnaissance and classification of military targets, damage assessment in military conflicts, etc.

The rapid development on airborne and spaceborne SAR systems opens new operational modes and configurations, such as bi- and multistatic setups. This unprecedented development in the SAR sensors requires definition of new techniques and algorithms for SAR data usage, as well as assessment of existing methods for SAR products exploitation.

The objective of this special issue, which was open to all researchers and contributors, was to select outstanding papers on recent scientific and technological progress in the field of SAR, bringing together experts from the research, industrial, and academic communities who are engaged in projects on the technologies and techniques of SAR. During EUSAR 2012, many new ideas and technological innovations have been presented in the field of spaceborne SAR, forward-looking SAR, digital beamforming, polarimetry, and polarimetric SAR interferometry.

For this TGRS special issue, we obtained an excellent resonance from the Call for Papers. As a result of a careful review process, 22 papers have been accepted for publication (additional five papers did not make this issue's publication deadline but can be found in the next issue). The papers of this special issue cover the most topical research areas in SAR techniques and technologies as bistatic SAR, innovative system concepts, polarimetric systems and data analysis, polarimetric SAR interferometry, as well as advanced processing techniques for image generation and information extraction.

It is hoped that the readers will appreciate the effort of the authors in composing this special issue. The organizers of EUSAR are grateful to the IEEE GRSS for their cooperation and for their generous offer to include these expanded papers in this issue. We are indebted to the authors for their cooperation and for their excellent contributions which will, it is hoped, make this special issue a rich resource for all those working in a SAR-related discipline. Finally, but most importantly, the assistance of the many reviewers is greatly appreciated in ensuring the rigour of the selection process and the quality of the published papers. The guest editors are also very grateful to Prof. Chris Ruf, former Editor of the IEEE TGRS, and Prof. Antonio Plaza, Editor of the IEEE TGRS, for their encouragement and support in preparing this special issue.

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Matthias Weiß received the Dipl.-Ing. degree in electrical engineering from Braunschweig University of Technology, Brunswick, Germany, in 1992 and the Dr.-Ing. degree in electrical engineering from the University of Kiel, Kiel, Germany, in 1998.

From 2000 to 2001, he was a Research Scientist with Milltronics Ltd., Peterborough, ON, Canada, where he initiated and was responsible for the development of new microwave radars for industrial measurement systems. Since 2001, he has been with Fraunhofer Institute for High Frequency Physics and Radar Techniques (FHR) [formerly Research Establishment for Applied Science (FGAN)], Wachtberg, Germany, where he works on bi- and multistatic radars, digital beamforming, 3-D imaging by combining downward-looking radar with the synthetic aperture principle, and compressive sensing for sensor fusion in a distributed radar network. He is the author or coauthor of many papers in journal publications and various international conferences and is the holder of three patents.

Dr. Weiß is the Executive of the biennial "European Conference on Synthetic Aperture Radar" (EUSAR) and the Program Chairman of EUSAR 2010 and EUSAR 2012. He has organized and contributed to several NATO lecture series, several workshops on bi- and multistatic radar techniques, and two NATO symposiums. In 2012 and 2013, he organized the International Workshop on Compressed Sensing Applied to Radar (CoSeRa) in conjunction with J. Ender and H. Rauhut. Since the beginning of 2009, he has been responsible for the organization of the International Summer School on Radar/SAR, which takes place once a year with the intention of bringing together young scientists around the world with international experts in the field of radar and SAR. He served as a Guest Editor for the Special Section in "IET Radar, Sonar & Navigation" on EUSAR 2008 published in 2009 and as an Associate Editor for a Special Issue of the IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING in 2011 and 2013.

Joachim H. G. Ender (M'02–SM'06) received the degree in mathematics and physics from the University of Münster, Münster, Germany, and the Dr.-Ing. degree in electrical engineering from Ruhr University Bochum, Bochum, Germany.

After receiving his undergraduate diploma, in 1976, he joined Fraunhofer Institute for High Frequency Physics and Radar Techniques (FHR) [formerly Research Establishment for Applied Science (FGAN)], Wachtberg, Germany, where he worked on statistical theory of detection and estimation, phased-array antennas, imaging radar, radar signal processing problems, and the design, construction, and airborne operation of experimental SAR systems. In 2003, he became the Director of FHR. Since 1992, he has been giving annular lectures on radar signal processing at three universities and was awarded with the title "Honorary Professor" in 2002. Since December 2011, he has been the Chair for high-frequency sensors and radar techniques at the University of Siegen, Siegen, Germany, continuing to lead FHR. His current interests with respect to his own research are very high-resolution SAR imaging, 3-D SAR, multibaseline and wideband processing techniques for across-track SAR interferometry, and ground moving-target detection with air- and space-based radar, including multistatic satellite constellations, inverse SAR for moving-target imaging, autofocus, bistatic SAR processing, MIMO radar, passive coherent location, and compressive sensing applied to radar.

Dr. Ender was one of the founding members of the European Conference on Synthetic Aperture Radar (EUSAR), which started in 1996 and takes place biennially. In 2009, he founded, with the support of M. Weiß, FHR's "International Summer School on Radar/SAR," bringing together young scientists from all over the world for one week to gain education on radar and SAR techniques by distinguished international lecturers. In 2012, he, H. Rauhut, and M. Weiß organized the first "International Workshop on Compressed Sensing Applied to Radar" (CoSeRa). During the last decades, he has received several awards. Recently, in 2012, he has been the recipient of the "Group Technical Achievement Award—For contributions to Array Signal Processing and Multichannel Synthetic Aperture Radar" and the "Best Paper Award" for a journal publication on compressive sensing from the European Association for Signal Processing (EURASIP).

Christoph H. Gierull (S'94–M'95–SM'02) received the Dipl.-Ing. and Dr.-Ing. degrees in electrical engineering from Ruhr University Bochum, Bochum, Germany, in 1990 and 1995, respectively.

Since 2011, he has been an Adjunct Professor at Laval University, Quebec City, QC, Canada. From 1991 to 1994, he was a Scientist with Fraunhofer Institute for High Frequency Physics and Radar Techniques (FHR) [formerly Research Establishment for Applied Science (FGAN)], Wachtberg, Germany. In 1994, he joined the German Aerospace Center (DLR), where he headed the synthetic aperture radar (SAR) simulation group at the Microwaves and Radar Institute until 1999. Since 2000, he has been a Senior Defence Scientist with the Radar Systems Section, Defence Research and Development Canada (DRDC), Ottawa, ON, Canada. During the Space Shuttle Radar Topography Mission in February 2000, he was responsible for the X-band-SAR on-orbit performance at the Johnson Space Center, Houston, TX, USA. From 2006 to 2009, he was a Guest Scientist at FHR, collaborating on performance enhancement of ground moving-target indication (GMTI) modes on PAMIR and RADARSAT-2. After returning to Canada, he assumed the duties of Group Leader of Space-Based Radar at DRDC in 2011. He has been an International Expert Advisor to the Canadian Space Agency and to the European Space Agency on several of their future space-based radar missions, including RADARSAT Constellation and Sentinel-1. His work concentrates on various aspects of radar (array) signal processing, including adaptive jammer suppression, space–time adaptive processing, superresolution, airborne and multichannel spaceborne SAR in combination with MTI and HRWS, as well as bistatic and passive SAR. He is the author or coauthor of numerous peer-reviewed journal publications. Furthermore, he authored the chapter on GMTI for RADARASAT-2 in *Application of Space-Time Adaptive Processing* (IET, 2004).

Dr. Gierull was the recipient the ITG Paper Prize Award from the VDE in 1998 and the Best Paper awards (coauthor) at the International Radar Conference 2004 and again at EUSAR 2006. He was a member of the scientific program committees of 16 international conferences and served as an Associate Editor for a Special Issue in EURASIP's Signal Processing in 2004 and in the IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING in 2011 and 2013.