

The 1997 IEEE MTT-S International Microwave Symposium/Microwave Week: "High Frequencies in High Places"

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I. INTRODUCTION

THE 41st annual IEEE MTT-Society International Microwave Symposium (IMS), the primary event of the 1997 "Microwave Week," took place in Denver, Colorado, on June 8–13, 1997. The historic return of this event to Colorado occurred after a 24-year hiatus. It had been held twice before in Colorado; in 1962 at the laboratories of the then National Bureau of Standards in Boulder [1] and again in 1973 on the campus of the University of Colorado at Boulder [2]. Many extraordinary changes have taken place in the MTT Symposium during the intervening years, with details shown in Table I, which demonstrates well the dramatic growth of this conference. Where once the IMS could be adequately accommodated in a small college town such as Boulder, this was no longer true by the 1980's and 1990's. The very large exhibition, which has become a major and very important adjunct to the conference, now dictates that the IMS can only be held in medium-to-large-sized cities having major convention center facilities. The completion of the new Colorado Convention Center in Denver in the early 1990's finally made it possible to bring the IMS back to Colorado in 1997.

Today's IMS is only one component of what has now come to be known as "Microwave Week," including two other conferences that were formerly sponsored by or affiliated with the MTT-Society: the Radio Frequency Integrated Circuits Symposium (RFICS, formerly the MMWMC Conference) and the Automatic RF Techniques Group (ARFTG) Conference. These take place at the beginning and end of Microwave Week, respectively. There exists considerable overlap in the registration for these three conferences. Another major component is the Exhibition, organized by Horizon House Publications, and its associated Microwave Application and Product Seminars. The social events have always been a traditional part of Microwave Week and include the IMS Awards Banquet, the RFICS Reception, the *Microwave Journal*–MTT-S Reception, and the Industry-hosted Cocktail Reception which precedes the Banquet. Lastly, a comprehensive Guest Program is always organized for accompanying spouses, including a hospitality suite and various tours/outings.

II. REGISTRATION STATISTICS

The registration statistics are shown in Table II.

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Fig. 1. The Colorado Convention Center in Denver, site of the 1997 Microwave Week events.

TABLE I
STATISTICS FOR RECENT AND PAST SYMPOSIA HELD IN COLORADO

EVENT	1962 IRE PG-MTT National Symposium	1973 IEEE PG-MTT International Microwave Symposium	1997 IEEE MTT-S International Microwave Symposium
Location,	NBS Labs Boulder, CO	University Colorado, Boulder, CO	Colo. Convention Center, Denver, CO
Dates	22-24 May 1962	4-6 June 1973	8-13 June 1997
IMS Attendance	465	586	2174
No. Papers given	36 in 10 sessions, 1-track	119 in 15 sessions, 2-track	413 in 55 sessions, 5-track
Digest	1 Volume	1 Vol., 343 pages	3 Vols, 1830 pages
No. Panels & Workshops	None	3 1	6 24
TPC Members	8	50	240
TPC Chair/Co-chairs	R. Beatty, NBS	R. Beatty & E. Komarek, NBS	K.C. Gupta & Z. Popovic, CU
No. Exhibitors	None	15	375; 521 booths
Steering Committee Members	18	20	42
Steering Committee Chair	G.E. Schafer, NBS	D.F. Wait, NBS	H. Haddad, Ball; C.M. Weil, NIST
Local Arrangements Chair	J.F. Brockman, NBS	R. L. Gallawa, ITS	R. Seeley

In general, we consider these registration statistics to be most impressive and far in excess of our most optimistic projections. They truly reflect the outstanding success achieved in Denver during Microwave Week. By comparing these statistics with those published last year for the 1996 IMS

TABLE II
REGISTRATION STATISTICS FOR THE 1997 MICROWAVE WEEK ACTIVITIES

IEEE MTT-S International Microwave Symposium	2174
RFIC Symposium	727
ARFTG Conference	205
TOTAL Conference Registration	2518
Panel Sessions (IMS & RFICS)	1453
Rump Session	180
Workshop Registrations	
Sunday	635
Monday	1230
Friday	910
	TOTAL: 2775
Exhibition Only	5781
TOTAL REGISTRATION (All Events)	8585

[3, Th. I], some very interesting trends are readily apparent. Although the registration for IMS was down slightly from last year (2174 versus 2299), both the RFICS and ARFTG saw increases of approximately 25%. It is clear that the RFICS is attracting a sizable and increasing proportion of the total conference registration, reflecting increased interest amongst attendees in the technical areas of interest to RFICS. Registration for the lunchtime Panel Sessions also increased 13% from 1289 at IMS'96 to 1453. An increase that is equally significant is in the number of registered workshop participants (2775 versus 2496), further confirming a major growth trend that has now been evident for several years. The inescapable conclusion emerging from both our experiences and those of other organizers is that the workshop format is becoming very popular to many Microwave Week attendees. This is undoubtedly due to the more informal and slower pace of the workshop setting, which frequently allows for relaxed one-on-one interactions between the presenters and the audience and obviously frees the presenters from the kind of time constraints that they are subject to in the regular conference sessions. The ever-increasing popularity of the workshops is a factor that needs to be paid attention to by all future conference organizers.

III. THE TECHNICAL PROGRAM

A. IMS Technical Sessions

The majority of technical presentations during the 1997 Microwave Week strongly confirmed the important shift that the microwave industry has recently undergone from the earlier high-cost low-volume environment of military applications to the current low-cost high-volume environment of the commercial marketplace. Many papers reported on state-of-the-art advances covering a very broad frequency spectrum in many of the booming fields of commercial telecommunication applications, such as wireless, PCS, fiber optics, MMDS, LMDS, etc. (For further details, see K. C. Gupta and Z. Popović, "1997 IMS Technical Program," this issue, pp. 2172-2174.)



Fig. 2. Leaders of the 1997 IMS Steering Committee: (from left) Bob Seeley, Local Arrangements Chair; K. C. Gupta, Technical Program Co-chair; Roger B. Marks, Vice Chair, Plenary Session and ARFTG Chair; John Dunn, Treasurer; Motohisa Kanda, Vice Chair and Special Sessions; Claude M. Weil, General Chair.

The IMS is renowned for the very thorough review process that all potential technical contributions are subjected to, which always results in a very high-quality technical program. Out of a total of 752 submissions, the IMS'97 Technical Program Committee (TPC) accepted a total of 413 papers for presentation at 55 technical sessions in a five-track format. This represents a 55% acceptance rate. Five of these 55 sessions were organized Focused Sessions; most dealt with very specific technical areas, but one was devoted to the history of microwave metrology at NBS/NIST in Boulder. Another regular session, dealing with developments in millimeter and submillimeter waves, was devoted to the memory of J. C. Bose, an Indian physicist who performed some extraordinary pioneering experiments at 60 GHz over a century ago (see also Section IV). Three of the regular sessions were jointly sponsored by both IMS and RFICS and one jointly sponsored by IMS and ARFTG. 132 of the 413 accepted papers were presented at two Interactive Forum (poster) sessions, in which the audience could discuss some of the issues presented by authors over snacks, fruit, wine, and beer.

B. Student-Paper Competition

In addition, 32 of the platform presentations authored or co-authored by students were entered in the IMS Student-Paper Competition, which this year involved three separate sessions. As a novel innovation in 1997, all student competition participants were awarded travel grants, intended to provide partial reimbursement for travel expenses incurred by them. We believe that such grants encourage greater student participation in the IMS and we hope that this precedent will be repeated in future years.

C. Panel Sessions and Workshops

Six lunchtime panel sessions, five sponsored by IMS and the sixth by RFICS, and the evening "rump" session all featured presentations by invited panelists as well as lively interactive discussions between the audience and panelists. A total of 24



Fig. 3. Part of the 1997 IMS Exhibition, Colorado Convention Center, Denver.

workshops, (10 full-day and 14 half-day) were featured as part of the IMS Program. These featured a tutorial or short-course setting for professional development in which attendees can closely interact with invited specialists. They covered important areas of emerging technologies, as well as business aspects, government regulations, and web-site design.

D. The Plenary Session

In order to further highlight the important commercial telecommunication themes of the 1997 IMS, this year's Plenary Session was devoted to two new telecommunication infrastructures. Bernard Bossard, chief technical officer and co-founder of CellularVision USA, discussed his company's pioneering work in 28-GHz local multipoint distribution systems (LMDS's), which can potentially provide customers with wide-band wireless links for telephone, high-speed data, and multichannel TV applications at much reduced capital investment. The other plenary speaker, Robert Dixon, chief scientist of Omnipoint Corporation of Colorado Springs, questioned whether the real promise of personal communication system (PCS) wireless communications, including high-speed data service, have been met. He concluded that due to various factors, primarily economic, PCS is currently little more than digital cellular telephony operating on upper frequency bands. At the conclusion of the Plenary Session, awards were presented by MTT-S President R. E. "Skip" Bryan, to the leaders of the 1996 IMS Steering Committee, led by Chairman E. J. Crescenzi, Jr., as well as three of this year's MTT-S graduate fellowship winners.

E. Publications

The work of the Technical Program cannot be considered complete until the IMS Digest is published. As is shown in Table I, this has now grown to a three-volume, 12-lb monster. Additional copies of the Digest can be obtained from the IEEE, Publication Order Department, 445 Hoes Lane, Piscataway, NJ 08855-1331; please quote IEEE Catalog no. 97CH36037 and ISSN: 0149-645X. Because of the many advantages inherent in the use of CD-ROM's as a storage medium, the organizers



Fig. 4. The 1997 IMS Steering Committee. First Row, Left to Right: D. Williams, C. Repjar, S. Seeley, R. Booton, Robbie Marks, Roger B. Marks, S. Ganchev, C. Weil (Chair), M. Kanda, R. DeLyser, K. C. Gupta, J. Tary, R. DeGroot, C. Whitehead. Second Row: J. Dunn, K. Varian, R. Ehret, R. O'Rourke, R. Loewecke, J. Norgard, D. Wait, J. Meredith, A. Repjar, G. Jankovic, R. Seeley. Missing: Z. Popović, H. Frey, A. Sreenivas, G. Koepf, C. Jelks, D. Huebner, J. Donovan, R. Kagiya, C. Coates, J. Jargon, M. Janezic, D. Russell, A. Weiser, J. Scupin.

of this year's IMS followed the lead of the IMS'96 organizers in again preparing a CD-ROM that contains all of the IMS and RFICS technical papers. New this year were titles and abstracts of MTT-S publications since 1989. All IMS and RFICS registrants again received this at no extra cost. This year, considerable effort went into creating a much improved system that is more user friendly and which is capable of retrieving title and abstracts in considerably less time.

IV. EXHIBITION AND MICROWAVE APPLICATION AND PRODUCT SEMINARS

For many years now, the Microwave Week events have included the largest and most comprehensive Exhibition of its kind in the microwave industry, organized by Horizon House Publications under contract to the MTT Society. This year's event, which posted a total of 521 revenue booths and 375 participating companies, even exceeded last year's record participation. This undoubtedly reflects the renewed economic growth and sense of optimism which the microwave industry is currently enjoying. The early concerns of those who feared that Denver would not attract a very sizable exhibition audience were answered by the extraordinarily large and steady exhibition traffic, which astonished even the Exhibition organizers. This year's Exhibition included 16 university booths, five of which occupied (for the first time) a full booth.

The Exhibition has also traditionally included the Microwave Historical Exhibit. Besides the historical artifacts that are normally loaned to IMS by the Historical Electronics Museum, Inc., Baltimore, Maryland, there were some significant additions to this year's Historical Exhibit. These included some early microwave standards and instruments provided by the National Institute of Standards and Technology in Boulder, as well as a special display and live demonstration of the 60-GHz instrumentation used by J. C. Bose, who performed many pioneering investigations into the quasi-

TABLE III
THE 1997 IEEE MTT-S INTERNATIONAL MICROWAVE SYMPOSIUM STEERING COMMITTEE

Chair Claude M. Weil, NIST		
Vice Chair, Plenary Session & ARFTG Chair Roger B. Marks, NIST	TPC/Publications Support Larry R. & Margaret Whicker, LRW Associates	Convention Center Coordinator Ray Kagiya, HP
Vice Chair, Special Sessions Motohisa Kanda, NIST	Fianace John Dunn, CU Helen Frey, CU John Tary	Guest Program & Transportation Robbie Marks
Technical Program Co-Chairs K. C. Gupta & Zoya Popovic, University of Colorado at Boulder	Registration George Jankovic, RF Globalnet Website	Signs Christie Whitehead, HP
Workshop Coordinators Donald DeGroot, NIST Ajay Sreenivas, Ball Corp. John Meredith, HP	Publicity Ronald DeLyser, DU George Rinard, DU Jeffrey Jargon, NIST	Awards Banquet Carol & Andy Repjar, NIST
Interactive Forum John Norgard, UCCS	Secretary Michael Janezic, NIST	Chairman's Dinner & Chairman's Reception Carolie Coates, CU
Student-Paper Contest Stoyan Ganchev, CSU	RFICS Liaison Dylan Williams, NIST	Industry Relations/Microwave Applications & Product Seminars Robert O'Rourke, Boulder Microwave Technologies Dick Loewecke, Odyssey 1 Gerome Reeve, NIST
Digest Editor Gerhard Koepf, SCT	Chief of Protocol David Wait, NIST	Exhibition Managers Harlan Howe, Jr. & Howard Ellowitz, Horizon House Publications
CD-ROM Editor Chris Jelks, Lockheed Martin	AdCom Liaison Karl Varian, TI	Historical Exhibit David Russell
Digest & CD-ROM Support Joseph Donovan, Lockheed Martin Doanld Huebner, Lockheed Martin Charlie Jackson, TRW	Local Arrangements Chair TPC Meeting Arrangements HQ Hotel Coordinator Bob Seeley, Monitor Labs	University Booths Dick Ehret, H. Bass Associates
Transactions Guest Editor & Gifts Richard Booton	Events Coordinator, Catering & AV Sharon Seeley	Student Help Attila Weiser, Jr. & Jonathan Scupin, SCT

optical properties of millimeter waves over a century ago. Those who visited the display were astonished to learn that such sophisticated technology, including spark generators, waveguide filters, dielectric lenses, absorbers, semiconductor detectors, etc. were already in use at that time. By special arrangements, these artifacts had been brought to Denver by Prof. A. K. Sen of the University of Calcutta and D. Sen, the curator of the J. C. Bose Museum in Calcutta, for whose IMS participation and collaboration we are most grateful.

Following the precedent set last year, the Microwave Application and Product Seminars (μ APS) were again presented on the exhibition floor. A program totaling 38 papers ran continuously during regular exhibition hours, including lunch, in a one-track format. These seminars, which were free to all technical registrants as well as the exhibition-only attendees, were intended to provide useful and up-to-date information on new microwave products and techniques for design, manufacturing, marketing, and managerial professionals. This year, we

sought to better publicize the μ APS and it appeared that these efforts did pay off through much improved attendance.

V. THE SOCIAL FUNCTIONS

Microwave Week would not be complete without the traditional social functions that are held throughout the week. The first event was the RFICS Reception, which took place on Sunday evening at the Denver Marriott Hotel. This was followed by the traditional *Microwave Journal*-MTT Reception, held on Monday evening at the Denver Museum of Natural History. For this function, the Museum was reserved exclusively for our use and included free access to all of the museum exhibits as well as an IMAX film. As an innovation to this year's IMS, we hosted a complimentary breakfast for all MTT members on both Tuesday and Wednesday mornings. This provided members with an opportunity to interact with MTT AdCom and TPC members as well as renew old friendships and chat with colleagues. Tuesday evening found

many IMS participants and their guests at Coors Field in lower downtown Denver to watch the Rockies–Braves baseball game. But the premier social event continues to be the IMS Awards Banquet. Some 600 people attended this event in the Grand Ballroom of the Headquarters Hotel, the Adam's Mark, on Wednesday evening. At this function, the 1997 MTT-S awards were presented by the MTT-S President R. E. "Skip" Bryan, and Honorary Life Fellow Ted S. Saad. In addition to recognizing the major microwave awardees and presenting the new IEEE Fellows (see D. N. McQuiddy, Jr., "1997 MTT-S Awards," this issue, p. 2175), certificates of recognition were also presented to the outgoing MTT-S President, J. W. Wassel, and three retiring AdCom members, J. M. Golio, D. C. Webb, and R. E. Lehmann. Presentations were also made by Stoyan Ganchev to the winners of the IMS Student-Paper Contest (First-Place Winner: Katherine Herrick, University of Michigan). "Four Hands, Two Grands" piano entertainment by Larry Wagoner and John Kite of Denver followed the awards ceremony.

Due to its close proximity to Colorado's magnificent Rocky Mountains, Denver, is always a very popular tourist attraction. Consequently, many attendees were accompanied by their spouses and families, who enjoyed a varied and well-balanced Guest Program. We provided a hospitality suite at the historic Brown Palace Hotel for the exclusive use of accompanying guests and we also organized a program of in-town tours, featuring some of Denver's cultural attractions, as well as two out-of-town tours to the Rocky Mountain National Park and to Colorado Springs.

ACKNOWLEDGMENT

To repeat an old cliché, the secret of success (and the 1997 Microwave Week was an enormous success by any standards) is a team of dedicated, committed, and hard-working individuals. Without any doubt, such a description fits the 1997 IMS Steering Committee (see Table III). As we all know, the IEEE relies almost entirely on unpaid volunteers to organize its conferences and other functions. There is very little reward in this hard work, much of which is done on the volunteers' own time, other than the satisfaction of working together toward a common and worthy goal and of knowing that everyone did a truly outstanding job. Nor is there ever enough recognition given to these dedicated people, many of whom toil unrecognized and in anonymity. To all of our outstanding committee members, we want to say a big "thank you" and hope that this short tribute will help recognize their dedication, hard work, and accomplishments.

An undertaking of this magnitude cannot possibly succeed without the professional support and encouragement given to committee members by its various employers (see Table III). We wish to acknowledge this generous support, particularly that given by the National Institute of Standards and Technology, which was an official technical sponsor of the Symposium, as well as the Hewlett-Packard Co., which contributed prizes for the Student-Paper Contest, plus a grant to assist in defraying expenses associated with the Historical Exhibit. We also acknowledge the support of the National Science Foundation which provided a grant to help defray student travel expenses.

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Claude M. Weil (M'64–SM'84) was born in Newcastle-on-Tyne, U.K., on June 26, 1937. He received the B.Sc. degree from the University of Birmingham, Birmingham, U.K., in 1959, the M.S.E. degree from George Washington University, Washington, DC, in 1963, and the Ph.D. degree from the University of Pennsylvania, Philadelphia, in 1970, all in electrical engineering.

He has devoted much of his career to microwave metrology and instrumentation. From 1960 to 1963, he worked as a Civilian Engineer at the Navy's Bureau of Ships, Washington DC, where he developed RFI instrumentation and designed electronic systems for naval vessels. In 1964, he joined Radiation Systems Inc., Alexandria, VA, where he designed microwave components and antennas. From 1971 to 1983, he was associated with the Environmental Protection Agency's research program on the health effects of RF radiation in Research Triangle Park, NC, where he developed animal exposure facilities and RF dosimetry instrumentation. From 1983 to 1985, he worked for the Boeing Military Aircraft Company, Seattle, WA, where he performed RCS measurements on scaled target models and investigated the reflectivity of absorbing materials at millimeter waves. In 1986, he joined the Electromagnetic Fields Division of the National Bureau of Standards (now NIST), Boulder, CO, where he developed millimeter-wave six-port systems and power standards. He currently serves as Project Leader of the NIST Electromagnetics Properties of Materials Program.

Dr. Weil is a senior member of the IEEE Microwave Theory and Techniques and the Instrumentation and Measurements Societies and Sigma-Xi.

Roger B. Marks (S'86–M'87–SM'91), for a photograph and biography, see this issue, p. 2165.



Motohisa Kanda (S'67–M'68–SM'83–F'88) received the B.S.E.E. degree from Keio University, Tokyo, Japan, in 1966, and the M.S.E.E. and Ph.D. degrees from the University of Colorado at Boulder, in 1968 and 1971, respectively.

From 1965 to 1966, he was a Research Technician at Keio University, where he did research on the avalanche breakdown in the germanium $p-n$ junction at a cryogenic temperature. From 1966 to 1971, he was a Research Assistant at the University of Colorado at Boulder, where he conducted research on impact ionization of impurities in n -type germanium, and nonreciprocal behavior in a solid-state plasma at millimeter and submillimeter wavelengths. In 1971, he joined the staff of the Electromagnetic Fields Division, National Institute of Standards and Technology (formerly Bureau of Standards), Boulder, CO, where he is currently Leader of the Fields and Interference Metrology Group. Concurrently, he serves as a Professor Adjoint in the Electrical and Computer Engineering Department, University of Colorado at Boulder.

Dr. Kanda is an editor of the IEEE TRANSACTIONS ON ELECTROMAGNETIC COMPATIBILITY. From 1990 to 1993, he was chairman of the U.S. Commission A of the International Union of Radio Science (URSI). From 1994 to 1996, he was vice chairman, and was elected to serve as chairman of the International Commission A of URSI from 1997 to 2000. He was the recipient of the Bronze Medal (1981, 1992) and Silver Medal (1989) from the U.S. Department of Commerce. He has received three IEEE EMC Transaction Best Paper Awards (1982, 1989, 1992), as well as other numerous awards from the IEEE EMC Society and the U.S. Department of Commerce.