

AUTHORS — JULY 1987

FUSION REACTORS

A FUSION REACTOR FOR SPACE APPLICATIONS

Terry Kammash (right) [BS, aeronautical engineering, Pennsylvania State University, 1952; PhD, nuclear engineering, University of Michigan (UM), 1958] served as a consultant on controlled fusion research at Lawrence Livermore National Laboratory, Argonne National Laboratory, Oak Ridge National Laboratory, and Battelle Pacific Northwest Laboratories. **David L. Galbraith** (photo not available) (BS, engineering physics, Cornell University, 1957; MS, 1959, and PhD, 1977, nuclear engineering, UM) is currently an assistant research scientist at UM. His areas of interest include theoretical analysis of fusion reactors and computer programming.

*Terry Kammash
David L. Galbraith*



TOKAMAK FUSION REACTOR START-UP SIMULATION

K. M. Ling (top) (BA, mathematics and physics, Ohio Wesleyan University, Delaware, Ohio, 1975; MS, electrical engineering, 1978, and DSc, 1980, Washington University, St. Louis, Missouri) is a research scientist in the Controlled Thermonuclear Research Division at Los Alamos National Laboratory. His research interests include the study of equilibrium and stability conditions for toroidal plasmas. **S. C. Jardin** (center) (BS, engineering physics, University of California, 1970; MS, physics and nuclear engineering, Massachusetts Institute of Technology, 1973; PhD, astrophysical sciences, Princeton University, 1976) is a research physicist and lecturer at Princeton Plasma Physics Laboratory (PPPL). His present research concerns equilibria, stability, and transport in toroidal plasmas. **F. W. Perkins** (bottom) (BA, Harvard University, 1956; PhD, Cornell University, 1964) is a senior research physicist and lecturer at PPPL. His research includes radio-frequency heating and confinement scalings in toroidal plasmas.

*K. M. Ling
S. C. Jardin
F. W. Perkins*



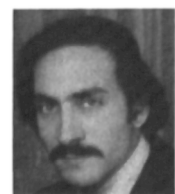
UPDATED REFERENCE DESIGN OF A LIQUID-METAL-COOLED TANDEM MIRROR FUSION BREEDER

David H. Berwald (top right) (BS, applied physics, Cornell University, 1974; MS and PhD, nuclear engineering, University of Michigan, 1977) is a program manager in the energy systems department of the Grumman Aerospace Corporation. He was formerly with the TRW Space and Technology Group and began his career working for the Exxon Corporate Research Laboratories. His primary fusion interests involve magnetic and inertial fusion reactor technologies in general and fusion systems optimization studies and breeding blankets in particular. His current activities also include space power systems and Strategic Defense Initiative (SDI)-related conceptual design and systems studies. Other interests include reactor safety, power generation economics, and fusion nuclear development. **R. H. Whitley** (top left) [MS, 1976, and PhD, 1984, nuclear engineering, University of California, Los Angeles (UCLA)] is a member of the systems engineering department of the Advanced Technology Division of TRW. He has worked primarily in the area of fusion systems simulation at TRW since 1980. Current projects also include radiation transport and shielding, isotope enrichment, experimental facility design, and fusion component availability assessment. **J. K. Garner** (second from top right) (BS, mechanical engineering, University of California, Santa Barbara, 1980; MS, mechanical engineering, UCLA, 1985) is head of the Design Analysis Section of the Energy Division at TRW in Redondo Beach, California. He has worked primarily in the area of fusion blanket design at TRW since 1980. A photograph and biography were not available for **R. J. Gromada**. **Thomas J. McCarville** (second from top left) [BSME, Arizona State University, 1977; PhD, University of Wisconsin (UW), Madison, 1982] is currently a member of the Energy Development Group at TRW. His research interests are in the area of engineering design and analysis for magnetic and inertial confinement fusion devices. He is currently a member of the TRW design team for mirror fusion test facility-B. **Ralph W. Moir** (third from top right) (ScD, nuclear engineering, Massachusetts Institute of Technology, 1967) has worked on the magnetic fusion project at Fontenay-aux-Roses, France (Centre d'Etude de l'Energie Nucléaire-Commissariat à l'Energie Atomique). In 1968, he joined Lawrence Livermore National Laboratory (LLNL), where he has specialized in development of the direct conversion of fusion plasma energy to electrical energy and reactor design. At present, he is head of the fusion-fission hybrid reactor design study project and serves as associate program leader for advanced mirror systems. **Joseph D. (J. D.) Lee** (third from top left) (BS, electrical engineering, Duke University, 1961; MS, nuclear engineering, University of New Mexico) is a member of the Mirror (Fusion) Reactor Studies staff at LLNL. He started investigating the potential of fusion/fission in 1969 and is one of its principal spokesmen. He joined LLNL full time in 1966 to work on the SNAP 50 project after working two summers on LLNL's "Fran" and "Super Kukla" prompt burst reactors. He has been involved in LLNL's fusion program since 1968. **Bernard R. Bandini** (bottom right) [BS, nuclear engineering, Pennsylvania State University (PSU), 1983] is a graduate student in nuclear engineering at PSU and is being supported by the Nuclear Science and Engineering and Health Physics Fellowship administered by Oak Ridge Associated Universities for the U.S. Department of Energy (DOE). His interests are in fusion neutronics and fission reactor shielding and core analysis. **Fred J. Fulton** (bottom left) (BS and MS, metallurgical engineering, University of Nevada, 1956) has worked with beryllium in nuclear weapons and other programs at LLNL since 1956. He is currently the LLNL member of the DOE Beryllium

*David H. Berwald
R. H. Whitley
J. K. Garner
R. J. Gromada
Thomas J. McCarville
Ralph W. Moir
Joseph D. Lee
Bernard R. Bandini
Fred J. Fulton
Clement P. C. Wong
Isaac Maya
C. G. Hoot
Kenneth R. Schultz
Lowell G. Miller
Joseph M. Beeston
Bob L. Harris
Russell A. Westman
N. M. Ghoniem
George Orient
W. G. Wolfer
Jackson H. DeVan
Peter F. Tortorelli*



Coordinating Committee. **Clement P. C. Wong** (top right) (BS and MS, nuclear engineering, UW; PhD, nuclear engineering, University of Texas) has been involved in the design of blankets on several different fusion reactor studies since joining GA Technologies, Inc. (GA) in 1977. His research interests are in the areas of fusion reactor blanket thermal-hydraulics and magnetohydrodynamic (MHD) effects and the assessment of tritium breeding materials. He has coordinated the blanket designs on the small reactor, tandem mirror hybrid reactor, and moving ring reactor studies. He led the material and design selection for the Lithium Blanket Module Study. Currently, he is the principal investigator, representing GA for the Fusion Breeder Program Reactor Study and the Blanket Comparison and Selection Study. **Isaac Maya** (top left) (PhD, nuclear engineering sciences, University of Florida) is now a senior research fellow with the Innovative Nuclear Space Power Institute at California State University, Long Beach. He is currently pursuing research on innovative and advanced nuclear reactors (gaseous core), power conversion systems (MHD), and related enabling components and procedures for space power systems applicable to the missions of the SDI. The work contained in this paper was performed while employed at GA. A photograph and biography were not available for **C. G. Hoot**. **Kenneth R. Schultz** (second from top right) (PhD, nuclear engineering sciences, University of Florida, 1971) is a manager of fusion development and technology at GA. He is responsible for the fusion nuclear technology aspects of several reactor design study projects for tokamak, mirror, and inertial confinement reactor applications, with emphasis on blanket engineering. He also is involved with several small blanket technology experiments. **Lowell G. Miller** (center left) (MS, nuclear physics and mathematics, University of Utah, 1958) is a senior program specialist with the Fusion Technology Program at the Idaho National Engineering Laboratory. He is involved in blanket testing issues, especially those blanket concepts containing beryllium. He is conducting several small beryllium experiments, i.e., beryllium multiplication measurements using a manganese bath. **Joseph M. Beeston** (third from top right) (PhD, metallurgical engineering, University of Utah, 1953) is a senior specialist on radiation effects. He was formerly with EG&G Idaho, Inc., but is presently retired. **Bob L. Harris** (bottom left) (PhD, mechanical engineering, Utah State University, 1974) is an engineering specialist at EG&G Idaho, Inc. He has been a stress analyst for the past 15 years and has had experience in the analysis of nuclear components constructed from beryllium. He has had considerable experience with the use of Section III of the ASME code at elevated temperatures. **Russell A. Westman** (no photo available) (PhD, civil engineering, University of California, Berkeley, 1962) is a professor in the mechanical, aerospace, and nuclear engineering department at UCLA. His research field is solid mechanics with a special interest in analytical fracture mechanics applied to metallic and composite structural components. **N. M. Ghoniem** (bottom right) (BS, nuclear engineering, University of Alexandria, Egypt, 1971; M. Eng., engineering physics, McMaster University, Canada, 1974; MS and PhD, nuclear engineering, UW, 1977) has been an assistant professor at UCLA since 1977. He has worked for one summer (1974) in the Reactor Physics Branch of Whiteshell Nuclear Reactor Establishment, Manitoba, Canada. He also spent part of the 1981 summer working with the Radiation Effects Group at the Oak Ridge National Laboratory (ORNL). His research interests are in the areas of radiation damage and effects in solids, pulsed irradiation, theoretical modelings of materials behavior in fission and fusion reactor, fusion technology, and computational methods. **George Orient** (no photo available) (MS, mechanical engineering, UCLA, 1985) is working on his PhD at UCLA. He has been involved in several



fusion reactor and blanket studies and currently participates in the TITAN project. His main interests are plastic fracture mechanics with special emphasis on creeping materials, structural and heat transfer analysis, and lifetime prediction of fusion reactor components. A photograph and biography were not available for **W. G. Wolfer**. **Jackson H. DeVan** (top) (BS, metallurgical engineering, Stanford University, 1952; MS, metallurgical engineering, University of Tennessee, 1960) is a research metallurgist in the Metals and Ceramics Division at ORNL and is currently on a 1-year appointment to Harwell Laboratory. He has conducted corrosion studies at ORNL since 1954 and served as group leader in corrosion for over 30 years. His areas of specialization include corrosion of alloys by lithium and by molten fluoride salts. **Peter F. Tortorelli** (bottom) (BS, physics, Manhattan College, 1973; PhD, metallurgy, University of Illinois, 1978) is a research metallurgist in the Metals and Ceramics Division of ORNL. He has spent considerable time studying liquid-metal corrosion in support of the fusion alloy development program and also has research projects in high-temperature oxidation and aqueous corrosion.



EXPERIMENTAL DEVICES

A MACROSCOPIC STUDY OF THE NEUTRON, GAMMA- AND X-RAY EMISSIVITY IN THE FRASCATI PLASMA FOCUS

Jan S. Brzosko (top) [MSc, PhD, DSc, nuclear physics, Warsaw University (WU), Poland] has served as director of the Physics Institute, dean of the science faculty, and head deputy for science and research in the Bialystok Division of WU. He has worked in neutron physics and discharge physics. Since 1981, his research has been devoted to fusion physics and technology, mainly nuclear diagnostics of plasmas and nuclear technology of the fusion reactor blanket. He spent 2 years at the Joint Institute of Nuclear Research, USSR, and 5 years at the European Nuclear Energy Agency (ENEA) Frascati Center, Italy. He joined the Plasma Focus Laboratory at Stevens Institute of Technology, Hoboken, New Jersey in 1985. **B. V. Robouch** (center) (DesSc, nuclear physics, Université de Lyon, France) is presently responsible for the Fusion Reactor Blanket Program at the ENEA Frascati Center. After having been at the European Council for Nuclear Research-Geneva in the accelerator research group, he has been engaged since 1962 at the Euratom-ENEA Association Frascati Center, Italy, as a CCE staff member, in plasma physics research. His scientific activity has been centered on plasma focus physics and numerical methods applied to fusion plasmas. **Joanna Klobukowska** (bottom) (MSc, experimental physics, Torun University, Poland) is a researcher in the Bialystok Division of WU. She has worked in discharge physics and, since 1980, fusion plasma physics. She spent 2 years at the ENEA Frascati Center, 1-MJ Plasma Focus Laboratory.

*Jan S. Brzosko
B. V. Robouch
Joanna Klobukowska*



SIMILARITIES BETWEEN THE PLASMA VORTEX FILAMENTS (RELATIVISTIC AND NONRELATIVISTIC) OBSERVED IN THE PLASMA FOCUS AND IN CONVENTIONAL RELATIVISTIC ELECTRON-BEAM MACHINES

Winston H. Bostick (University of Chicago, 1934-41) wrote his doctoral thesis on cosmic rays. During World War II, he worked in the pulse generator group at the Massachusetts Institute of

Winston H. Bostick



Technology radiation laboratory. From 1954 to 1956, he performed pioneer work at Lawrence Livermore National Laboratory on the properties of plasmoids, which are formed when plasma from plasma guns is fired into a vacuum or low-pressure gas chamber that is immersed in a magnetic field. In 1956, Bostick assumed the duties of full professor and head of the physics department at Stevens Institute of Technology (SIT), where he continued his research on plasma physics. In 1979, he took leave of absence from SIT to work on electron-beam research at the Air Force Weapons Laboratory.

SPECIAL FEATURES OF FIRST-WALL HEAT TRANSFER IN LIQUID-METAL FUSION REACTOR BLANKETS

K. Taghavi (top) [PhD, mechanical engineering, University of California, Los Angeles (UCLA), 1982] worked with the fusion program at UCLA from 1982 to 1985 on thermal-fluid aspects of fusion reactors. He is currently an assistant professor of mechanical engineering at the University of Kentucky. His research interests include thermal hydraulics and safety of fusion and nuclear reactors. **M. S. Tillack** (center) (SM, 1980, and PhD, 1984, nuclear engineering, Massachusetts of Technology) is a senior development engineer at UCLA in the fusion engineering program, working primarily on the FINESSE project to investigate issues of fusion nuclear technology development. His specific research interests also include various aspects of blanket/first-wall engineering, such as liquid-metal magnetohydrodynamics (MHD), corrosion, and electromagnetic effects. **H. Madarame** (bottom) [Dr. Eng., University of Tokyo (UT), Japan, 1976] is an associate professor in the Department of Nuclear Engineering, UT. He was a visiting associate research engineer in the fusion engineering program at UCLA from 1984 to 1985. His current interests include MHD flow in a fusion reactor blanket.

*K. Taghavi
M. S. Tillack
H. Madarame*



14-MeV NEUTRON MULTIPLICATION MEASUREMENT IN LEAD

Om Prakash Joneja (top) [MSc, Punjabi University, India, 1966; graduate, Bhabha Atomic Research Centre (BARC) Training School, India, 1967; PhD, physics, University of Bombay, India, 1976] has been actively working on fast neutron spectrometry and development of Monte Carlo codes. His present interest includes development of new experimental techniques for on-line measurement of tritium breeding in fusion blankets. He has worked at the Institute for Reactor Development (IRD), Jülich, Federal Republic of Germany (FRG), from 1972 to 1974 in the field of fast neutron spectrometry and from 1979 to 1980 on the LiAlO₂ blanket assembly for measuring tritium production. **Vijay R. Nargundkar** (bottom) (MSc, physics, Karnataka University, India, 1956; PhD, pulsed neutron studies, University of Bombay, India, 1966) has been working at BARC since 1957. He has worked in the field of fission physics at Atomic Energy of

*Om Prakash Joneja
Vijay R. Nargundkar
Tejen Kumar Basu*



Canada, Ltd., Chalk River, Canada (1961 and 1962), pulsed fast reactors at the Joint Institute for Nuclear Research, Dubna, Soviet Union (1972), and fusion blanket neutronics at the IRD, Jülich, FRG (1977 and 1978). He has been the facility supervisor of the Purnima Critical Facility. His current interest is theoretical and experimental studies of fusion blanket neutronics. **Tejen Kumar Basu** (right) (BS, physics, Kurukshetra University, India, 1969; graduate, BARC Training School, India, 1970; PhD, physics, University of Bombay, India, 1980) has been associated with the experimental program of the Purnima fast reactor facility. He worked at the IRD, Jülich, FRG from 1977 to 1978 in fusion blanket neutronics. His current interests include neutron transport calculations in micropellets and the experimental investigation of neutron multipliers.



TRITIUM SYSTEMS

MINIMIZATION OF THE TRITIUM CONTENT WITHIN THE FIRST WALL OF A TOKAMAK REACTOR

*A. Nicolai
P. Börner*

A. Nicolai (top) [PhD, nuclear physics, University of Giessen, Federal Republic of Germany (FRG), 1970] is a staff member at the Institut für Plasmaphysik der Kernforschungsanlage (KFA) Jülich, FRG. He has worked on transition probabilities due to gamma-ray radiation, plasma transport, energy confinement, and plasma equilibrium in tokamaks. In particular, he has contributed to the modeling of neutral injection heating, bundle divertors, plasma transport in the scrape-off region of limiters, neutral gas transport evoked by pump limiters, and the permeation of hydrogen species through the first wall of tokamak reactors. **P. Börner** (degree, Industrie und Handelskammer, Cologne, FRG, 1978) has worked on one- and two-dimensional transport codes for tokamak plasmas on a Poisson solver for axisymmetric magnetic fields resorting to finite elements and on Monte Carlo codes describing the neutral gas transport. She is a staff member at the Institut für Plasmaphysik, KFA Jülich.



MATERIALS ENGINEERING

COMPARISON OF INELASTIC RESPONSE OF TYPE 316 STAINLESS STEEL AND HT-9 MATERIALS ON THE FUSION REACTOR FIRST WALL

Ge-Ping Yu

Ge-Ping Yu (BS, nuclear engineering, National Tsing Hua University, Taiwan, 1974; MS, nuclear engineering, National Tsing Hua University, Taiwan, 1978; ScD, nuclear engineering, Massachusetts Institute of Technology, 1981) is an associate professor in the nuclear engineering department at the National Tsing Hua University. He has researched the fields of nuclear material engineering and reactor safety analysis. His current research is on the stress corrosion cracking of steam generator materials and failure analysis of the fusion reactor first wall.



POWER TRANSPORT TO THE POLOIDAL DIVERTOR EXPERIMENT SCOOP LIMITER

H. W. Kugel (top right) (PhD, nuclear physics, University of Notre Dame) is a research physicist at Princeton Plasma Physics Laboratory (PPPL). His interests include neutral beam operations, diagnostics, and armor and infrared temperature measurements of power control surfaces. His recent work involves coordinating the development of diagnostics for Tokamak Fusion Test Reactor (TFTR) neutral beam operations. **R. Budny** (top left) (PhD, theoretical particle physics, University of Maryland) is a research physicist at PPPL. He coordinated experimental investigations of the Poloidal Divertor Experiment (PDX) scoop limiter and performed scrapeoff measurements in PDX and the Princeton Large Torus. His present interests include edge modeling and pumped limiter design. **R. Fonck** (second from top right) (PhD) is a research physicist at PPPL. His work has involved optical diagnostic measurements of PDX plasmas and coordinating diagnostic development and operations for the Princeton Beta Experiment (PBX). His recent interests include optical ion temperature profile measurements of TFTR plasmas. **R. Goldston** (second from top left) (PhD, astrophysics, Princeton University) is a principal research physicist at PPPL. His interests have included plasma diagnostic techniques based on neutral hydrogen beams, fast ion charge-exchange (CX) diagnostics, neutral beam injection physics, and confinement scaling in tokamaks. He is presently manager of the TFTR Physics Program Division. **B. Grek** (photo not available) (PhD) is a research physicist at PPPL. He has performed extensive TV Thompson Scattering (TVTS) studies of PDX, PBX, and TFTR plasma electron temperature and density profiles. His present interests include development of advanced TVTS diagnostics for PBX-M plasma studies. **R. Kaita** (third from top right) (PhD, nuclear physics, Rutgers University) is a research physicist at PPPL. His interests include fast ion CX diagnostic techniques and diagnostic applications of neutral hydrogen beams. He has performed extensive studies of CX ion temperatures and beam ion thermalization effects in PDX, PBX, and TFTR plasmas. **S. Kaye** (third from top left) (PhD, earth and space sciences, University of California, Los Angeles) is a research physicist at PPPL. His interests include transport studies of PDX, PBX, and TFTR plasmas; probe measurements of PBX edge plasmas; magneto-hydrodynamic (MHD) magnetics analysis; and PBX tokamak operation. His recent interests include correlation studies of PBX high-beta plasmas, *vis-à-vis* MHD activity, and confinement. **R. J. Knize** (bottom right) (PhD, physics, Harvard University) is a staff research physicist at PPPL. His work has involved measurements of PDX scoop limiter edge conditions, plasma/surface interaction studies, and plasma polarization methods. His recent interests involve ZrAl bulk gettering studies and energy removal and particle control analysis for TFTR plasmas. **D. Manos** (bottom left) (PhD) is a research physicist at PPPL. He has performed extensive calorimetry, implantation, and probe measurements of PDX, PBX, and TFTR edge plasmas. His recent interests include coordinating TFTR diagnostic development for deuterium-tritium plasma operations. **R. McCann** (photo not available) (MS) is a senior engineer at PPPL. His interests include the development of plasma modeling techniques, transport analysis codes, and computational methods for PDX, PBX, and TFTR plasma regimes. **D. McCune** (photo not available) (BS) is a senior engineer at PPPL. His interests include the

H. W. Kugel
R. Budny
R. Fonck
R. Goldston
B. Grek
R. Kaita
S. Kaye
R. J. Knize
D. Manos
R. McCann
D. McCune
K. McGuire
D. K. Owens
D. Post
G. Schmidt
M. Ulrickson



development of computational methods, transport analysis, and plasma modeling codes for PDX, PBX, and TFTR plasma regimes. **K. McGuire** (top right) (PhD, D. Phil., plasma physics, Oxford University) is a research physicist at PPPL. His interests include extensive studies of MHD effects and instabilities in PDX, PBX, and TFTR plasmas. He is presently deputy manager of the TFTR Physics Program Division. **D. K. Owens** (top left) (PhD) is a research physicist at PPPL. His interests have included PDX tokamak operation, fueling studies, limiter and divertor thermal deposition measurements, and probe measurements of plasma edge conditions. He is presently interested in TFTR operation and pellet injection fueling studies. **D. Post** (center right) (PhD, physics, Stanford University) is a principal research physicist at PPPL. His interests have included plasma TV measurements of PDX edge plasma and scoop limiter behavior. He has worked primarily in the computational modeling of tokamaks and the application of atomic processes to fusion research. **G. Schmidt** (bottom left) (PhD) is a research physicist at PPPL. His interests have included microwave interferometer density measurements, bolometer measurements, pellet injector development, and fueling studies. He is presently responsible for pellet injector operations on TFTR. **M. Ulrickson** (bottom right) (PhD, nuclear physics, Rutgers University) is a research physicist at PPPL. His interests have included the design of the PDX neutral beam inner wall armor, the design of the PDX scoop limiter, the design of the TFTR inner bumper limiter and outer protective plate, infrared temperature measurements, and energy control and particle removal studies for PDX, TFTR, and the International Tokamak Reactor.



PLASMA HEATING SYSTEMS

MULTIMODE ANALYSIS OF A DUAL ELECTRON-BEAM QUASI-OPTICAL GYROTRON

Yasuyuki Itoh (top) (PhD, nuclear engineering, Osaka University, Japan, 1981) works at Toshiba Research and Development Center, Toshiba Corporation. He is currently engaged in the development of powerful gyrotrons for plasma heating. **Tohru Sugawara** (MS, applied physics, University of Tokyo, Japan, 1970) is a senior scientist at Toshiba Research and Development Center, Toshiba Corporation. His research interests are plasma heating and power sources.

*Yasuyuki Itoh
Tohru Sugawara*



ICF DRIVER TECHNOLOGY

ALIGNMENT OF THE EIGHT-BEAM OCTAL LASER

Michel Josse (MS, University of Paris, France, 1972; PhD, University of Paris-Orsay/Observatoire de Meudon, France, 1976) worked at the Commissariat à l'Energie Atomique (CEA) in the area of lidar research in 1976. In 1977, he worked at the Institute National de Astronomia, Optica y Electronica de Puebla,

Michel Josse



Mexico, in the areas of telescope lens testing, diffraction gratings on silicon, and optical testing. He has been employed at CEA since 1978. He is currently interested in intermediate resonance thermal testings.

MATERIALS ENGINEERING

AN ANALYTICAL FORMULA FOR THE CONCENTRATION DISTRIBUTION OF IMPLANTED IONS

*Janusz Martan
Andrzej Mulak*

Janusz Martan (top) (MD, vacuum technology, Technical University of Wrocław, Poland, 1973; PhD dissertation, Technical University of Wrocław, 1977) has worked in research and has lectured at the Institute of Electron Technology, Technical University of Wrocław. His scientific work covers ion implantation, ion beams, ion sources, and ion optics. **Andrzej Mulak** (Ms Eng, electronics, Politechnika Wrocławska, Poland, 1959; MS, mathematics, University of Wrocław, Poland, 1968; D Eng, 1965, and D.Sc/D. hab., 1975) has been with the Institute of Electron Technology of Politechnika Wrocławska, Poland, since 1959. He was appointed professor in electronics in 1985. He has worked on numerous theoretical and experimental problems of electron optics and surface science. Currently, he is involved in charged-particle/solid-state interaction.



PLASMA ENGINEERING

ANOMALOUS TEMPERATURE EQUILIBRIA DUE TO $E \times B$ DRIVE

J. Rand McNally, Jr.

J. Rand McNally, Jr. (PhD, physics, Massachusetts Institute of Technology, 1943) is retired from the senior research staff in the Fusion Energy Division of Oak Ridge National Laboratory. His research interests include atomic physics, plasma physics, and nuclear fusion in which fields he has published well over 100 technical articles. He is now a fusion energy consultant.

