

AUTHORS — NOVEMBER 1989

OVERVIEW

TECHNICAL ISSUES IN FUSION REACTORS — A REVIEW

Vijay Kumar Rohatgi (top) (PhD, physics, University of California, Berkeley, 1957) is the director of the electronics and instrumentation group and the head of the Plasma Physics Division at Bhabha Atomic Research Center (BARC), Bombay, India. Prior to joining BARC, he worked with the General Electric Company; the Atomic Energy Research Establishment, Harwell, England; and Harvard University, Cambridge, Massachusetts. He was also adjunct research professor at the University of Bombay. **Thottathil Vijayan** (PhD, physics, University of Bombay, Bombay, India, 1983) has been working in the Plasma Physics Division, BARC since 1967 on generation and transport of electron beams and their interactions with targets and plasmas. Prior to joining BARC, he taught physics at Government College, Kasaragod, India. His present interests include beam/plasma interactions and particle beam acceleration.

*Vijay Kumar Rohatgi
Thottathil Vijayan*



BLANKET ENGINEERING

SUBCOOLED WATER FLOW BOILING AT 1.66 MPa UNDER UNIFORM HIGH HEAT FLUX CONDITIONS

Ronald D. Boyd, Sr. (BSME, Tuskegee University, 1968; PhDME, University of Michigan, 1976) is currently a professor in the Department of Mechanical Engineering at Prairie View A&M University. He is conducting research on high heat flux removal from fusion reactor components, space cold plate enhancement, mixed convection in plumes, and natural convection in enclosures. Between 1985 and 1988, he was head of the mechanical engineering department and chairman of the Engineering Research Council. His interests include theoretical and experimental (including optical) analyses of thermal transfer and transport processes.

Ronald D. Boyd, Sr.



INVESTIGATION OF THE NEUTRONIC POTENTIAL OF MODERATED AND FAST (D,T) HYBRID BLANKETS FOR REJUVENATION OF CANDU SPENT FUEL

Sümer Şahin (top) (MS, mechanical engineering, 1967, and PhD, nuclear engineering, 1970, University of Stuttgart, Federal Republic of Germany; habilitation, physics, University of Ankara, Turkey, 1973) has worked at the Radiation Shielding Information Center, Oak Ridge National Laboratory, with a postdoctoral NATO fellowship; at the Institute of Nuclear Energy of the Swiss Federal Institute of Technology in Lausanne, Switzerland, as advanced research scientist; at the King Saud University in Riyadh, Saudi Arabia, as professor; and also as professor and dean of the Faculty of Engineering at the University of Erciyes, Kayseri, Turkey. In 1987, he served as secretary general and chief executive of the Turkish Scientific and Technical Research Council (TÜBİTAK) and was elected vice-chair of the United Nations Intergovernmental Committee on Science and Technology for Development. He is chair of the special commission of the State Planning Organization of Turkey for the Mainframe Planning of Scientific Research and Technology. Currently, he is a professor and the director of the Institute of Science and Technology at Gazi University, Ankara, Turkey. His research field covers neutron transport theory, fusion-fission (hybrid) reactors, thermionic spacecraft reactors, and radiation shielding. **Hüseyin Yapıcı** (BSc, 1979; MSc, 1983; and PhD, 1989, mechanical engineering) is an academic staff member in the mechanical engineering department at Erciyes University, Kayseri, Turkey. His main interest is to compile computer codes, in particular nuclear engineering codes, and to execute them on different machines.

*Sümer Şahin
Hüseyin Yapıcı*



PLASMA ENGINEERING

STEADY-STATE OPERATION REGIME OF TOKAMAK REACTOR PLASMA: CONSISTENCY ANALYSIS

Sanae-Inoue Itoh (top right) (BS, 1974; MS, 1976; and PhD, 1979, physics, University of Tokyo, Japan) worked at the Institute for Fusion Theory, Hiroshima University, from 1979 to 1989. In 1989 she joined the National Institute for Fusion Science. She has worked on magnetic confinement theory. **Atsushi Fukuyama** (top left) (BS, electronics, 1974; MS, 1976; and PhD, 1981, Kyoto University, Japan) has been with the Department of Electronics, Okayama University, since 1977 and became an associate professor in 1985. He has been involved in the theoretical and numerical analysis of radio-frequency heating, current drive, and associated transport in fusion plasmas. **Tomonori Takizuka** (bottom right) (BS, electronics, 1970; MS, 1972; and PhD, 1975, Kyoto University, Japan) is a senior scientist at the Plasma Theory Laboratory, Japan Atomic Energy Research Institute (JAERI). He has worked on tokamak physics theory. His interests include alpha-particle transport, divertor plasma, and confinement theory. **Kimitaka Itoh** (bottom left) (BS, 1974; MS, 1976; and PhD, 1979, physics, University of Tokyo, Japan) is an associate professor at the National Institute for Fusion Science. He has worked at JAERI as a research physicist and at Kyoto University as an associate professor. He has worked on the theory of instability and transport in magnetic confinement plasmas.

*Sanae-Inoue Itoh
Atsushi Fukuyama
Tomonori Takizuka
Kimitaka Itoh*



EXPERIMENT AND ANALYSIS OF THE BEHAVIOR OF 14-MeV NEUTRONS IN A LARGE CAVITY

Hiroshi Nakashima (top) (MS, nuclear engineering, Tohoku University, Japan, 1984) has been a research scientist in the Department of Reactor Engineering at Japan Atomic Energy Research Institute (JAERI) since 1984. He has worked on experiments and analyses of radiation shielding of fusion facilities. His research interests also include radiation shielding of accelerator facilities. **Shun-ichi Tanaka** (center) (PhD, nuclear engineering, Tohoku University, Japan, 1978) has been a member of the research staff at JAERI since 1967. He has worked on experiments and analyses of radiation shielding and on dosimetry of fission and fusion facilities. He recently began a study of radiation dosimetry using synchrotron radiation. **Tomoo Suzuki** (bottom) (BS, applied mathematics, 1960, and D. Eng., reactor engineering, 1977, Tokyo University, Japan) has been head of the JAERI Department of Reactor Engineering Shielding Laboratory since 1980. He has worked on criticality and burnup code development for fast reactors at JAERI since 1960 and is now in charge of developing the BERMUDA transport code system.

*Hiroshi Nakashima
Shun-ichi Tanaka
Tomoo Suzuki*



COLD FUSION

HOW A RECTANGULAR POTENTIAL IN SCHRÖDINGER'S EQUATION COULD EXPLAIN SOME EXPERIMENTAL RESULTS ON COLD NUCLEAR FUSION

Johann H. Schneider (no photo available) (PhD, physics, University of Vienna, Austria, 1961) worked at Siemens Company from 1961 to 1963 in the area of nuclear energy. In 1964 he became involved with high-energy physics at the Swiss Federal Institute of Technology. Since 1964 he has been a research scientist at the Joint Research Centre of the Commission of the European Communities. His activities include nuclear reactor physics, nuclear fuel cycle studies, fusion magnet safety, systems analysis, and industrial risk assessment. He is currently involved in tokamak fusion safety studies.

Johann H. Schneider

NUCLEAR REACTION PRODUCTS THAT WOULD APPEAR IF SUBSTANTIAL COLD FUSION OCCURRED

Dennis Mueller (top) (BS, physics and mathematics, MacMurray College, 1968; PhD, nuclear physics, Michigan State University, 1976) is a physicist at the Princeton University Plasma Physics Laboratory (PPPL), where he is currently section head of physics operations for the Tokamak Fusion Test Reactor. His interests include neutral beam heated plasmas, plasma/wall interactions, and transport studies. **Larry R. Grisham** (PhD, physics, Oxford University, United Kingdom) has been a physicist at PPPL since 1974. He has worked mainly in the application and development of neutral beam heating for magnetically confined plasmas.

*Dennis Mueller
Larry R. Grisham*



A STUDY OF "COLD FUSION" IN DEUTERATED TITANIUM SUBJECTED TO HIGH-CURRENT DENSITIES

Robert B. Campbell (top) (PhD, nuclear engineering, University of Michigan, 1980) is on location at Lawrence Livermore National Laboratory (LLNL) and is presently involved in the International Thermonuclear Experimental Reactor (ITER) tokamak design study effort. He is working in the areas of current drive and steady-state operation of ITER. His primary area of expertise is in the numerical simulation of plasmas. **L. John Perkins** (BSc, physics, 1974; MSc, nuclear engineering, 1975; and PhD, physics, 1978, University of Birmingham, United Kingdom) is a physicist in the Magnetic Fusion Energy Division at LLNL. He spent 1 year on the academic staff at the University of Birmingham undertaking research in experimental neutron physics allied to fusion blanket design followed by 2 years as a senior physicist at IRT Corporation in the same research area. Following this, he spent 3 years as a staff scientist in the Fusion Engineering Program at the University of Wisconsin in the field of conceptual fusion reactor design. His primary research interests at LLNL include plasma engineering, fusion reactor design, advanced fusion energy conversion concepts, advanced tokamak fueling methods, and physics and engineering scoping studies of tokamak engineering test reactors. He is currently one of the U.S. participants in the International Thermonuclear Experimental Reactor design study.

*Robert B. Campbell
L. John Perkins*



HIGH-SENSITIVITY SEARCH FOR NEUTRONS DURING ELECTROCHEMICAL REACTIONS

Michael A. Butler (photo not available) (BS, physics, Rensselaer Polytechnic Institute, 1964; PhD, physics, University of California-Santa Barbara, 1969) joined Bell Laboratories in 1970 to work on magnetic resonance in magnetic metals and lower dimensional organic conductors. In 1975, he moved to Sandia National Laboratories (SNL) to explore photoelectrochemistry as a potential solar energy conversion technique. Since 1983, he has worked in microsensor science studying new concepts in sensors, particularly optical sensors. A photograph and a biography for **D. S. Ginley** were not available at publication time. **James E. Schirber** (top) (BA, mathematics and physics, St. Johns University, 1953; PhD, physics, Iowa State University, 1960) has been with SNL since 1962 and has been manager of the solid state research department since 1968. His research activities include superconductivity, Fermi surface studies under pressure, and strained-layer superlattices. **Ronald I. Ewing** (bottom) (PhD, physics, Rice University, 1959) was co-developer of the Bonner sphere neutron spectrometer. He has been a member of the technical staff at SNL since 1959 and is currently involved in the development of specialized neutron and gamma detectors for a variety of applications.

*Michael A. Butler
D. S. Ginley
James E. Schirber
Ronald I. Ewing*



TRIALS TO INDUCE NEUTRON EMISSION FROM A TITANIUM-DEUTERIUM SYSTEM

Heinrich Werle (right) [Dr. Ing., University of Karlsruhe, Federal Republic of Germany (FRG), 1970] has worked at Kernforschungszentrum Karlsruhe (KfK) since 1965 on neutron physics and the safety of fast reactors and is currently involved in the physics and technology of fusion reactors. **Günter Fieg** (left) (Dr. Ing., University of Karlsruhe, FRG, 1971) has worked at KfK since 1965 on neutron physics and the safety of fast reactors. He

*Heinrich Werle
Günter Fieg
Josef Lebkücher
Manfred Mösckke*



is currently involved in the physics and technology of fusion reactors. **Josef Lebkücher** (right) is a senior technician at KfK, where he is involved in the design and operation of experimental facilities in fast reactor and fusion reactor work. **Manfred Möschke** (left) is a senior technician at KfK, where he is involved in the design and operation of experimental facilities in fast reactor and fusion reactor work.



SEARCH FOR COLD FUSION IN HIGH-PRESSURE D₂-LOADED TITANIUM AND PALLADIUM METAL AND DEUTERIDE

James E. Schirber (top) (BA, mathematics and physics, St. Johns University, 1953; PhD, physics, Iowa State University, 1960) has been with Sandia National Laboratories (SNL) since 1962 and has been manager of the solid state research department since 1968. His research activities include superconductivity, Fermi surface studies under pressure, and strained-layer superlattices. **Michael A. Butler** (photo not available) (BS, physics, Rensselaer Polytechnic Institute, 1964; PhD, physics, University of California-Santa Barbara, 1969) joined Bell Laboratories in 1970 to work on magnetic resonance in magnetic metals and lower dimensional organic conductors. In 1975, he moved to SNL to explore photoelectrochemistry as a potential solar energy conversion technique. Since 1983, he has worked in microsensor science studying new concepts in sensors, particularly optical sensors. A photograph and a biography for **D. S. Ginley** were not available at publication time. **Ronald I. Ewing** (bottom) (PhD, physics, Rice University, 1959) was co-developer of the Bonner sphere neutron spectrometer. He has been a member of the technical staff at SNL since 1959 and is currently involved in the development of specialized neutron and gamma detectors for a variety of applications.

*James E. Schirber
Michael A. Butler
D. S. Ginley
Ronald I. Ewing*



SEARCH FOR NEUTRONS FROM A TITANIUM-DEUTERIUM SYSTEM

George N. Kamm (top right) (PhD, physics, Wayne State University, 1963) has been a research physicist at the U.S. Naval Research Laboratory (NRL) since 1963. His major activity has been in the experimental aspects of materials physics with a goal of elucidating the electronic properties of metals. **Alexander C. Ehrlich** (top left) (PhD, physics, Carnegie Institute of Technology, 1963) was a research associate at the University of Lausanne, Switzerland, from 1963 to 1966 and came to NRL in 1966 as a National Research Council postdoctoral research associate. He is currently head of the electronic and magnetic properties group where he pursues studies of the electronic structure of conducting materials and its relationship to properties. **D. J. Gillespie** (bottom right) (PhD, physics, The American University, 1977) first joined NRL as a summer student aide in 1957. His research interests are metal-hydrogen systems and electronic transport in metals and semimetals. **William J. Powers** (bottom left) (BS, physics, University of Kentucky, 1964) joined NRL in 1967 as a health physicist. His current responsibilities include radiation safety at the various NRL accelerators.

*George N. Kamm
Alexander C. Ehrlich
D. J. Gillespie
William J. Powers*



NEGATIVE RESULTS AND POSITIVE ARTIFACTS OBSERVED IN A COMPREHENSIVE SEARCH FOR NEUTRONS FROM "COLD FUSION" USING A MULTIDETECTOR SYSTEM LOCATED UNDERGROUND

Ronald I. Ewing (top) (PhD, physics, Rice University, 1959) was co-developer of the Bonner sphere neutron spectrometer. He has been a member of the technical staff at Sandia National Laboratories (SNL) since 1959 and is currently involved in the development of specialized neutron and gamma detectors for a variety of applications. **Michael A. Butler** (photo not available) (BS, physics, Rensselaer Polytechnic Institute, 1964; PhD, physics, University of California-Santa Barbara, 1969) joined Bell Laboratories in 1970 to work on magnetic resonance in magnetic metals and lower dimensional organic conductors. In 1975, he moved to SNL to explore photoelectrochemistry as a potential solar energy conversion technique. Since 1983, he has worked in microsensor science studying new concepts in sensors, particularly optical sensors. **James E. Schirber** (bottom) (BA, mathematics and physics, St. Johns University, 1953; PhD, physics, Iowa State University, 1960) has been with SNL since 1962 and has been manager of the solid state research department since 1968. His research activities include superconductivity, Fermi surface studies under pressure, and strained-layer superlattices. A photograph and a biography for **D. S. Ginley** were not available at publication time.

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Michael A. Butler
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