

AUTHORS — MAY 1986

ICF CHAMBER ENGINEERING

INERTIAL CONFINEMENT FUSION DEVELOPMENT OPTIONS: FACILITY CHARACTERISTICS AND SCHEDULES FROM A REACTOR PHYSICS VIEWPOINT

James A. Blink



James A. Blink (BS, engineering science, University of Nevada, Reno, 1970; MS, nuclear engineering, Georgia Institute of Technology, 1971; PhD, engineering, University of California, Davis, 1984) has been an engineer at Lawrence Livermore National Laboratory in the Inertial Fusion Program since 1976. His technical activities have included neutronics, neutron activation, hydrodynamics, liquid-metal pump design, lithium compatibility with steel, liquid-metal safety, tritium solubility and containment, development facility planning, and assessment of military applications. He was a key participant in the HYLIFE and Pulse*Star reactor studies and has interacted extensively with the Electric Power Research Institute.

PLASMA HEATING SYSTEMS

TRANSPORT EFFECTS OF INTERACTING HOT AND COLD ELECTRONS IN LASER-HEATED PLASMAS

P. M. Campbell

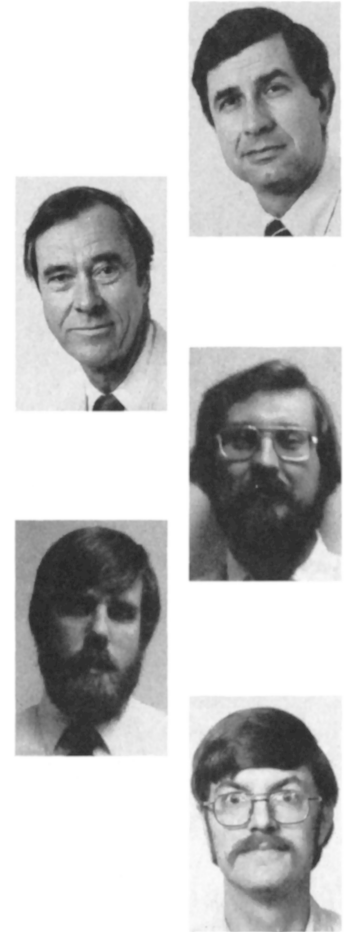


P. M. Campbell (PhD, University of Colorado, 1963) has worked on theoretical problems associated with inertial fusion for the last 13 years. His current interests include transport problems related to laser-driven plasmas, specifically heat transport anomalies in fusion targets and x-ray laser sources.

THE PERFORMANCE OF THE POLOIDAL DIVERTOR EXPERIMENT NEUTRAL BEAM WALL ARMOR

H. W. Kugel (top right) (PhD, nuclear physics, University of Notre Dame, 1967) is a research physicist at the Princeton Plasma Physics Laboratory (PPPL). He coordinates Princeton Beta Experiment (PBX) neutral beam operations and Tokamak Fusion Test Reactor (TFTR) neutral beam diagnostics. His current research interests include optimizing neutral beam heating performance and the development of neutral beam diagnostics. **H. P. Eubank** (top left) (PhD, physics, Brown University) was an assistant professor at Brown University from 1954 to 1959. Since 1959 he has worked at the PPPL on plasma confinement, heating with plasma guns and particle beams, and plasma diagnostics with particle beams. **T. A. Kozub** (center right) (MS, physics, Rutgers University, 1974) is a senior engineer at PPPL for the TFTR diagnostic neutral beam control system, PBX and Princeton Large Torus (PLT) neutral beam data acquisition and computer controls, and data acquisition for TFTR neutral beam diagnostics. He previously designed ion sources and systems for TFTR diagnostics. **M. D. Williams** (bottom left) (BS, electrical engineering, Rutgers University, 1976) is a senior engineer at PPPL. He is engineer-in-charge of neutral beam operations for the PLT, PBX, and TFTR projects. Previously he was responsible for the design and implementation of neutral beam control systems. **M. Ulrickson** (bottom right) (PhD, nuclear physics, Rutgers University, 1975) is a research physicist at PPPL. He is in the Applied Physics Division of the lab and is involved primarily in the physics aspects of the design of limiter and first-wall components for the tokamak fusion test reactor, the fusion engineering device, and the international tokamak reactor. This involves both modeling of the plasma edge and close interaction with the engineers doing the mechanical design.

*H. W. Kugel
H. P. Eubank
T. A. Kozub
M. D. Williams
M. Ulrickson*



FUSION REACTORS

THE ELUSIVE ISOBARIC REACTOR

Robert G. Mills [BSE, electrical engineering, Princeton University (PU), 1944; MA, mathematics, University of Michigan, 1947; PhD, nuclear physics, University of California, Berkeley, 1952] is director of the Interdepartmental Program in Plasma Science and Fusion Technology at PU and leads a cooperative effort between the School of Engineering and Applied Science and the Plasma Physics Laboratory. Associated with PU's controlled thermonuclear research program for more than 30 years, he is the author of numerous publications on the engineering aspects of fusion power.

Robert G. Mills



CONCEPTUAL DESIGN OF A MOVING-RING REACTOR: KARIN-I

A. Mohri (right) (Dr. Eng., Kyoto University, Japan, 1966) is a professor at the Institute of Plasma Physics (IPP), Nagoya University. He has worked in the field of experiments on toroidal systems, such as helical systems, tokamaks, compact tori, reversed field pinches (RFP), and relativistic electron beam

*A. Mohri
Y. Fujii-e
K. Ikuta
H. Momota
H. Naitou
Y. Nomura
Y. Tomita
M. Ohnishi*



(REB) rings, for more than a decade. **Y. Fujii-e** (top right) (Dr. Eng., Tokyo University, Japan, 1967) is a professor at the IPP. He has been working on engineering and liquid-metal fast breeder reactor safety. He is now interested in fusion system engineering and safety. **K. Ikuta** (top left) (PhD, plasma physics, Nagoya University, Japan, 1970) is an assistant professor at the IPP. He has been proposing various magnetic field configurations to confine plasmas, and has been working on particle beam equilibrium and stability. He is now interested in the electromagnetic acceleration of macroparticles. **H. Momota** (second from top right) (PhD, plasma physics, Kyoto University, Japan 1966) is a professor at the IPP. He has been working on the microinstabilities and stochastic phenomena of confined plasmas, and the development of superconducting coils. He is now interested in the advanced fusion fuel cycles using the field-reversed mirror configuration and the stabilization of its magnetohydrodynamic (MHD) modes by means of energetic particle beams. **H. Naitou** (second from top left) (PhD, plasma physics, Nagoya University, Japan, 1980) is an assistant professor at the IPP. He has been working on ideal MHD stability analyses on tokamaks. He is now interested in the energetic particle stabilization of ballooning modes. **Y. Nomura** (third from top right) (PhD, plasma physics, Nagoya University, Japan, 1985) is an assistant professor at the IPP. He has been working on the stochasticity of magnetic field lines, performance analysis of advanced fusion fuel cycles, and dissipative effects on RFPs. He is now interested in the sustainment of compact toroid configurations and the stabilization of their MHD modes by energetic particle beams. **Y. Tomita** (third from top left) (ME, electrical engineering, Kyoto University, Japan, 1975) is an assistant professor at the IPP. He has been working on the stochasticity of magnetic field lines and experiments with REB rings. He is now interested in the equilibrium and stability of beam plasma configurations. **M. Ohnishi** (fourth from top right) (Dr. Eng., electrical engineering, Kyoto University, Japan, 1979) is a research associate at the Institute of Atomic Energy, Kyoto University. He was a visiting assistant professor in the Nuclear Engineering Program of the University of Illinois from April 1979 for six months and held a visiting appointment at Lawrence Livermore National Laboratory (LLNL) from October 1979 to April 1980. His current interests include alpha-particle transport in magnetic fusion, dynamics and control of fusion reactors, and reactor design studies of open-ended systems. **K. Yoshikawa** (fourth from top left) (Dr. Eng., nuclear engineering, Kyoto University, Japan, 1974) is an associate professor at the Institute of Atomic Energy, Kyoto University. He held a visiting appointment at LLNL from October 1978 for one year and then stayed at Lawrence Berkeley Laboratory, University of California, until March 1980. His main interests are direct energy conversion, reactor relevant technology, and reactor design in nuclear fusion. **S. Inoue** (fifth from top right) (BE, electrical engineering, Osaka Institute of Technology, Japan, 1964) is a research assistant at Osaka University. He has been working on liquid-metal MHD generation, liquid-metal two-phase MHD, and the phenomenon of liquid-metal boiling. He is now interested in liquid-metal MHD pressure drop in various pipes and the heat transfer of lithium in a magnetic field. **M. Nishikawa** (bottom left) (PhD, nuclear engineering, Osaka University, Japan, 1972) is an associate professor on the faculty of engineering at Osaka University. His primary research interests include fusion reactor physics and technology for compact toroids, and application of functional materials to various apparatus in the energy field. **S.-Inoue Itoh** (bottom right) (PhD, physics, University of Tokyo, Japan, 1979) has been on the faculty at the Institute for Fusion Theory, Hiroshima University, since 1979 and became an associate professor in 1985. She has worked on magnetic

K. Yoshikawa
S. Inoue
M. Nishikawa
S.-Inoue Itoh
K. Kitamura
S. Nagao
H. Nakashima
M. Iwamoto
Y. Gomay
M. Kumagai
Y. Kawakita
Y. Suzuki
K. Okamoto
H. Matsunaga
H. Yoshizawa



heating and confinement theory. Her current interest involves the thermodynamic approach for confined plasmas. **K. Kitamura** (top right) (PhD, mechanical engineering, University of Tokyo, Japan, 1979) is a lecturer in the Department of Energy Engineering, Toyohashi University of Technology. He has been working in the field of liquid-metal MHD and heat transfer. **S. Nagao** (top left) (B.Sc., physics, 1943, and Dr. Sc., 1949, Hokkaido University, Japan) is a professor at the Engineering College, Chubu University. He was on the faculty of engineering, Tohoku University, working on the experimental study of plasma confinement in the helical axis stellarators (Asperator NP) until 1982. He is now interested in the torsatron-type configuration with a similar helical magnetic axis. **H. Nakashima** (second from top right) (PhD, nuclear engineering, Kyushu University, Japan, 1978) is an associate professor of energy conversion engineering at Kyushu University. He has been engaged in the nuclear design study of deuterium-tritium and deuterium-deuterium fusion reactors. His current interests include nuclear energy systems, fusion fuel cycles, and advanced fuel fusion reactors. **M. Iwamoto** (second from top left) (PhD, electrical engineering, Tokyo University, Japan, 1960) specializes in superconducting magnets for fusion reactors. He is a research manager at the Central Research Laboratory of Mitsubishi Electric Corporation. **Y. Gomay** (third from top right) (PhD, plasma physics, Tokyo University, Japan, 1970) is a senior researcher at the research and development (R&D) center of Toshiba Corporation. He has worked on plasma/wall interaction in tokamak devices. He is now interested in fusion reactor design. A photograph and a biography of **M. Kumagai** were not available at publication time. **Y. Kawakita** (third from top left) (Doshisha University, Japan, 1976) is a research engineer at the Beam Apparatus R&D Department of Nissin Electric Company, Ltd. He has been working on the development of pulsed power technology and the high-power CO₂ laser system. He is now involved in the development and design of the high-power, high-repetition rate excimer laser system. **Y. Suzuki** (fourth from top right) (Musashi Institute of Technology, Japan, 1964) is assistant manager of the engineering department's Ion Equipment Division of Nissin Electric Company, Ltd. He has been working on the development of pulsed power technology and the high-power CO₂ laser system. He is now involved in the development of ion implantation equipment and ion vapor deposition equipment. **K. Okamoto** (fourth from top left) (BS, Tokyo University, Japan, 1941) is a senior engineer at ULVAC Corporation, a vacuum engineering company, and is in charge of vacuum problems in nuclear fusion research. **H. Matsunaga** (bottom right) (BS, mechanical engineering, Osaka University, Japan, 1974) is a sales engineer at Toyo Information Systems Company, Ltd. He has been engaged in sales and consultations relative to CAD/CAM/CAE. **H. Yoshizawa** (bottom left) (MS, atomic engineering, Osaka University, Japan, 1978) is a chief analyst of network planning at Toyo Information Systems Company, Ltd. He has been engaged in consultation relative to information network planning and structural analysis.



BLANKET ENGINEERING

A PARAMETRIC STUDY OF WATER-COOLED SOLID BREEDER BLANKET DESIGNS

Balabhadra Misra (right) (PhD, chemical engineering, Columbia University, 1957) is a chemical engineer at Argonne National Laboratory. He has conducted calculational and experimental studies of heat transfer and fluid flow in conjunction with the space

*Balabhadra Misra
Grover D. Morgan*



program, the liquid-metal-cooled fast breeder reactor program, sodium technology program, and more recently, the controlled nuclear fusion program. His recent activities involve tritium technology and design/analysis of first-wall/blanket systems. **Grover D. (Dave) Morgan** (right) (BS, mechanical engineering, 1965, and MS, engineering mechanics, 1968, University of Missouri-Rolla) has been a systems integration analyst on the McDonnell Douglas Astronautics Company fusion energy staff since 1978. His primary interests were first-wall and blanket engineering and design. He was deputy manager of the Blanket Comparison and Selection Study, and was also responsible for all solid breeder blanket design group activities.



FUSION REACTORS

CONCEPTUAL DESIGN OF A DEUTERIUM-³He FUELED TANDEM MIRROR REACTOR SATELLITE/BREEDER SYSTEM

Geoffrey W. Shuy (no photograph available) is a research scientist at the Plasma Fusion Center at Massachusetts Institute of Technology (MIT). His background includes plasma physics, high-energy and nuclear physics, nuclear engineering, and system analyses. His main interests are in plasma engineering, advanced fusion fuels, fusion reaction kinetics, mirror confinement systems, and reactor concept study. **Ali E. Dabiri** (top) (BS, engineering, Teheran Polytechnic, 1967; MS, 1969, and ScD, 1971, engineering, MIT) is a senior scientist at Science Applications International Corporation. He has worked on many aspects of fusion engineering issues, including first-wall and blanket design of alternative fusion fuel reactors. He is currently involved in advanced fusion reactor studies and ignition devices. Past work includes gas/solid interactions, energy conservation, and energy systems. **Husam Gurol** (BS, nuclear engineering, 1971; MS, nuclear engineering, 1972; and PhD, nuclear engineering, 1975, University of Michigan) is an engineering specialist at General Dynamics, Energy System Division. His research areas include fusion reactor system studies, reactor safety, plasma engineering, effects of irradiation on materials, and high-field magnet analyses.

*Geoffrey W. Shuy
Ali E. Dabiri
Husam Gurol*



EXPERIMENTAL DEVICES

ENGINEERING ASPECTS OF THE HT-6M TOKAMAK

HT-6M Team

Photographs and biographies were not available at publication time.

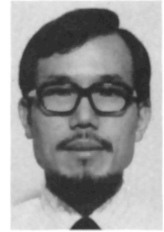
PULSE DISCHARGE CLEANING FOR OPEN-ENDED SYSTEMS

*Harold R. Garner
Takashi Aoki*

Harold R. Garner (right) (BS, University of Missouri, 1976; MS and PhD, plasma physics, University of Wisconsin, 1982) is currently a member of the GA Technologies, Inc./U.S. Department of Energy team of scientists working with the RFC-XX-M Tandem Mirror Group in Nagoya, Japan. He has been working with this group for 3 years. His major interests and responsibilities



include plasma confinement and related topics in tandem mirrors, in addition to coordinating the exchange group. **Takashi Aoki** (right) (BS, Nagoya Institute of Technology, 1978) is currently a member of the RFC-XX-M Tandem Mirror Group at the Institute of Plasma Physics in Nagoya, Japan. He has more than 10 years of experience in the field of high-power radio-frequency systems for ion cyclotron resonance frequency (ICRF) heating. His recent research interests include impurity control during ICRF heating and plasma/wall interaction studies on the RFC-XX-M device.



TRITIUM SYSTEMS

TRITIUM CONTROL IN A HELIUM-COOLED CERAMIC BLANKET FOR A FUSION REACTOR

Mario Dalle Donne (top) (PhD, engineering science, Bologna University, Italy, 1956) worked at Agip Nucleare, Italy, from 1956 to 1959, and at the Dragon Project, England, from 1959 to 1963. Since 1963 he has worked in the Federal Republic of Germany at the Kernforschungszentrum, Karlsruhe (KfK) Institut für Neutronenphysik und Reaktortechnik. Since 1976, he has been assistant professor at Karlsruhe University. He has worked in the fields of gas-cooled, water, and liquid-metal-cooled fission reactors and blankets for fusion reactors. His main technical interests are thermohydraulics, safety, and reactor assessment. **Stefan Dorner** (Dipl. Ing., metallurgical engineering, 1951, and Dr. rer. nat., 1953, Stuttgart Technical University) was with the Max-Planck-Institut für Metallforschung from 1949 to 1952, working on measurements of density and viscosity of liquid metals. From 1952 to 1961, he worked in various metallurgical industries. Since 1961, he has been involved in various material problems of fast breeder reactors at KfK. His current interests concentrate on materials for fusion reactor blankets.

*Mario Dalle Donne
Stefan Dorner*



DRASTIC REDUCTION OF COMPUTING TIME IN DYNAMIC SIMULATION FOR HYDROGEN ISOTOPE DISTILLATION COLUMNS

Masahiro Kinoshita (MS, 1979, and PhD, 1983, chemical engineering, Kyoto University, Japan) has worked on development of computer-aided simulation procedures and programs for stage processes both in the fuel cycle system for a fusion reactor and in other chemical engineering systems. He has also started preliminary experimental study for cryogenic distillation.

Masahiro Kinoshita



ICF TARGETS

A PROPOSED DIRECT ρR MEASUREMENT BY CHARGED-PARTICLE ACTIVATION

A. D. Krumbein (right) (PhD, physics, New York University, 1951) is advisory scientist in the plasma physics department at the Soreq Nuclear Research Center. This year he is a visiting professor at the Laboratory for Plasma and Fusion Energy Studies of the University of Maryland. His current research interests include

*A. D. Krumbein
Y. Paiss
H. Zmora
M. Rosenblum*



inertial confinement fusion and laser/plasma interactions. Photographs and biographies for **Y. Paiss**, **H. Zmora**, and **M. Rosenblum** were not available at publication time.

TRITIUM RELEASE FROM A LITHIUM CERAMIC: INTERPRETATION OF THE TRIO EXPERIMENT

Mario Dalle Donne



Mario Dalle Donne (PhD, engineering science, Bologna University, Italy, 1956) worked at Agip Nucleare, Italy, from 1956 to 1959, and at the Dragon Project, England, from 1959 to 1963. Since 1963 he has worked in the Federal Republic of Germany of the Kernforschungszentrum Karlsruhe Institut für Neutronenphysik und Reaktortechnik. Since 1976, he has been assistant professor at Karlsruhe University. He has worked in the fields of gas-cooled, water, and liquid-metal-cooled fission reactors and blankets for fusion reactors. His main technical interests are thermohydraulics, safety, and reactor assessment.

A ZIRCONIUM-COBALT COMPOUND AS THE MATERIAL FOR A REVERSIBLE TRITIUM GETTER

*Takanori Nagasaki
Satoshi Konishi
Hiroji Katsuta
Yuji Naruse*



Takanori Nagasaki (second from left) (MS, nuclear engineering, University of Tokyo, Japan, 1983) is a research scientist at the Function Materials Laboratory of the Japan Atomic Energy Research Institute (JAERI). His current interests are ionic conduction and hydrogen behavior in ceramics. **Satoshi Konishi** (left) (MS, nuclear engineering, University of Tokyo, Japan, 1981) is a research engineer at the Tritium Engineering Laboratory of JAERI. He has been working on the development of tritium processing technology relating to palladium diffusers and electrolyzers for the fusion fuel cycle. He is also interested in the property of solid blanket materials. **Hiroji Katsuta** (right) (PhD, engineering of metallic materials, Tohoku University, Japan, 1969) is chief of the Function Materials Laboratory of JAERI. His current interests are nonmetallic impurity behavior in liquid metals and molten salts and hydrogen behavior in ceramics. **Yuji Naruse** (third from left) (BS, chemical engineering, Kyoto University, Japan, 1959) is chief of the Tritium Engineering Laboratory at JAERI. He has been engaged in the engineering works related to fuel reprocessing and uranium enrichment. He is now involved in the design and construction of tritium facilities.