EXECUTIVE NEWSLETTER

JANUARY 1988

FUSION POWER ASSOCIATES

2 PROFESSIONAL DRIVE, SUITE 248 • GAITHERSBURG, MARYLAND 20879

(301) 258-0545

FOWLER LEAVES FUSION POST

T. Kenneth Fowler has accepted the position of chairman of the Nuclear Engineering Department at the University of California at Berkeley effective January 1. In so doing he will give up his post as Associate Director for Magnetic Fusion at the Lawrence Livermore National Laboratory, a position he has held since 1970. No successor to Fowler has yet been named. Fowler continues to serve as chairman of a technical oversight committee for the International Thermonuclear Engineering Reactor and expects to continue to interact with the fusion community in a variety of ways. Ken was recently named to the National Academy of Sciences, was a recipient of Fusion Power Associates Leadership Award in 1983 and is a member of Fusion Power Associates Board of Directors. Ken's new address is the University of California, Dept. of Nuclear Engineering, Etcheverry Hall, Room 4153, Berkeley, CA, 94720, (415) 642-5010.

FUSION AT THE SUMMIT

In the Joint Summit Statement, issued by Ronald Reagan and Mikhail Gorbachev following their December 7-10 Summit Conference in Washington, D.C., the following statement on fusion appears:

> "The president and general secretary supported further cooperation among scientists of the United States, the Soviet Union and other countries in utilizing controlled thermonuclear fusion for peaceful purposes. They affirmed the intention of the U.S. and the U.S.S.R. to cooperate with the European Atomic Energy Community (EURATOM) and Japan, under the auspices of the International Atomic Energy Agency, in the quadripartite conceptual design of a fusion test reactor."

The statement reaffirms previous statements issued after the Iceland and Geneva Summit meetings.

In the course of related activities during the Summit week, E. P. Velikhov, vice president of the USSR Academy of Sciences, speaking to a meeting of the U.S. Academy of Sciences, said that he hoped the joint design study of the International Thermonuclear Experimental Reactor (ITER) would become "more than just a paper project," saying that he thought that the U.S., Europe, Japan and the USSR should also build the facility.

The Energy Department was not previously able to overcome Defense Department objections to a joint construction project. Even though State Department officials said that Reagan's intent in the Geneva agreement with Gorbachev was "to build a fusion reactor," Energy Secretary Herrington refused to allow the DOE-DOD disagreement to be brought to Reagan for a decision, prefering to defer the issue by proposing a design study only. Such a study has now begun (see our November newsletter).

PRINCETON PHONE CHANGE

Effective December 14, the first three digits of the telephone number for Princeton Plasma Physics Laboratory will change from 683 to 243. Please make a notation in your phone directories.

MAJOR FUSION STUDY ISSUED

A 100 page "Summary of the Report of the Senior Committee on Environmental, Safety and Economic Aspects of Magnetic Fusion Energy" (ESECOM) has been issued as a Lawrence Livermore National Laboratory report UCRL-53766-Summary. Although funded

by DOE through LLNL, the study was national in scope and independent in nature. It was chaired by Prof. John P. Holdren of the University of California at Berkeley and prepared by a group of nine other individuals: Dave Berwald, Bob Budnitz, Jim Crocker, Jerry Delene, R. D. Endicott, Mujid Kazimi, Bob Krakowski, Grant Logan and Ken Schultz.

The group assessed eight fusion reactor possibilities, two fission-fusion hybrid designs and four nuclear fission reactor cases using consistent economic and safety models. The study concluded that magnetic fusion energy systems have the potential to achieve costs of electricity comparable to those of present and future fission systems, coupled with significant safety and environmental advantages. Copies of the Summary Report can be requested from Grant Logan's secretary Debbie Jalanivich at LLNL, Mail Stop L-644, Livermore, CA, 94550, (415) 423-1065.

NEW SCIENCE MAGAZINE

The frontiers of tomorrow's science and technology will be the focus of 21st Century Science and Technology, a new bimonthly science magazine scheduled to appear in January 1988.

"Our magazine will bring readers the ideas, experiments, and advanced technology necessary to take mankind to the 21st Century," said Editor-in-Chief Carol White, a former editor of Fusion Magazine. "We want to spark the kind of discussion and debate of fundamental scientific ideas that can reverse the prevailing antiscience climate in the schools and media."

The first issue will be 64 pages, with a cover story titled, "Two Days to Mars with Fusion Propulsion." Other feature stories include "Space Farming in the 21st Century," articles on the biological and political effects of radiofrequency weapons, and an article on Kepler's ideas of travel to the moon. The news coverage ranges from a report on the spread of AIDS through Latin America, to a review of the Soviet Beam Defense Program, and an update on Supernova 1987.

Subscriptions are $20 for 6 issues, and the cover price is $3. per copy. Checks and money orders made out to 21st Century should be sent to P.O. Box 65473, Washington, D. C., 20035.

NEW PLASMA INSTITUTE FORMED

The Lawrence Livermore National Laboratory and the University of California, Davis Department of Applied Science have co-sponsored the establishment of a new Plasma Physics Research Institute (PPRI). John Killeen is the acting director. The institute is designed to strengthen basic and applied plasma physics research throughout the University of California and at the Livermore Laboratory. The institute has a 1988 fiscal year budget of about $430,000. The institute's initial experimental project will be a small tokamak called the Davis Diverted Tokamak to be located at Livermore. However participants in the institute will have access to other facilities at Livermore such as the NOVA laser and the new Microwave Tokamak Experiment. For further information contact Tammy Packer at (415) 423-2576.

NEW SUPERCONDUCTIVITY NEWSLETTER

A new weekly newsletter entitled Superconductivity--Research, Development and Commercialization Report is being published by Business Publishers Inc., publishers of Fusion Power Report. Theckla Fabian, who edits Fusion Power Report, is also an editor of the new newsletter. For a sample copy of the charter issue or to subscribe ($459 per year), phone (301) 587-6300.

REVERSED FIELD PINCH STUDY

A study of the reversed field pinch concept as a fusion reactor has recently been completed under the direction of Bob Conn (UCLA). Two versions of the reactor, called TITAN-I and TITAN-II, were developed. Both produced 1000 MWe and are compact, having mass power densities of 700 kWe/tonne. Copies of the study and other related papers may be requested from Bob Conn at (213) 825-4544.

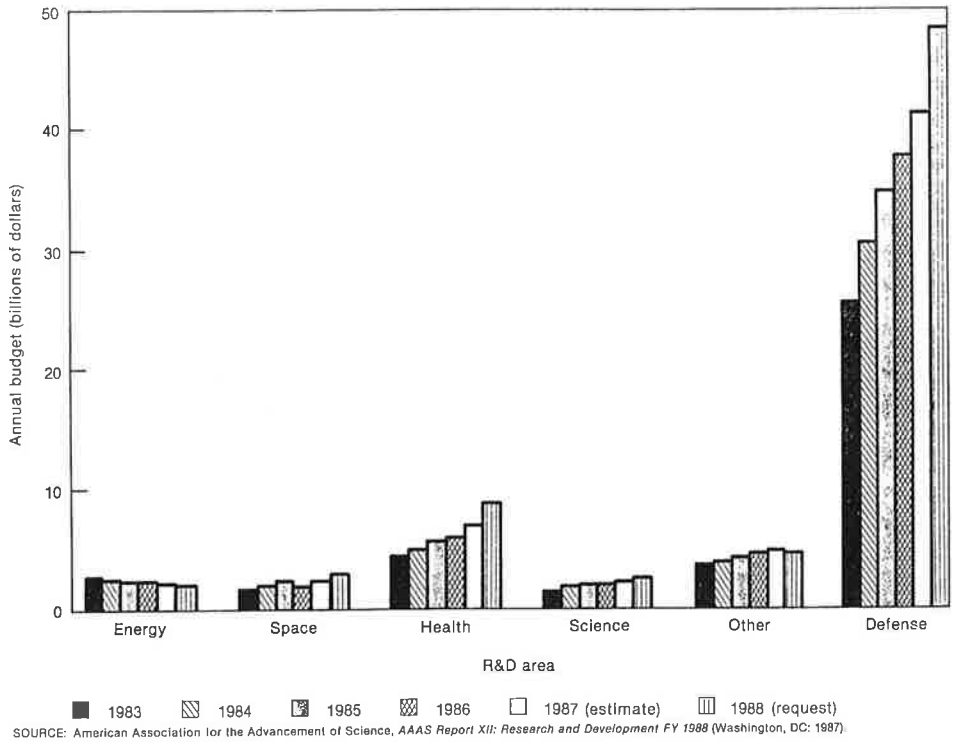
HERRINGTON CITES ADMINISTRATION'S SCIENCE AND TECHNOLOGY COMMITMENT

Speaking at the National Symposium on the Superconducting Super Collider in Denver December 3, Energy Secretary Herrington said that, "One of the unheralded stories of this administration is the massive commitment that has been made to ensure our continued scientific and technological leadership into the twenty-first century." The administration's "emphasis is support for high-risk research and development that cannot or will not be undertaken by the private sector alone," Herrington said. According to Herrington the FY 1988 request "represents a 50 percent increase in federal support for basic research since 1982." "At the Department of Energy alone, support for energy programs now totals nearly two billion dollars," Herrington said. "The President's goal is continued American leadership and development of the technical arsenal we need for the future and a continuation of the quest to find answers that will benefit future generations," he said.

Speaking of the multi-billion dollar supercollider, Herrington said, "The question some say is: Can we afford the super collider? And, in particular, can we afford a financial commitment of this magnitude when the nation's number one priority is to cut the federal deficit? Can we afford this kind of expenditure when this initiative offers no immediate economic benefits or absolute future guarantee of tangible benefits? The real question, however, is not: Can we afford to construct the super collider? It is: Can we afford not to?"

Speaking to the same group, New Mexico Senator Pete Domenici said there was "little chance" of getting the money needed to start building the collider next year. Rep. Ralph Hall, who chairs the House Science, Space and Technology's subcommittee on international scientific cooperation told the conference that "Given the current budget climate in the House, now is not the time to bring a major new spending measure to the floor." Hall pointed out that, in addition to the $5 billion SSC, the Science Committee is looking at a space station costing $16-30 billion, the human genome project estimated at $3 billion, a doubling of the National Science Foundation budget at a cost of $1 billion annually for 10 years and the proposed University Research Facility Revitalization Act, expected to run $2.5 billion annually.

Historical Component Funding Levels of Federal R&D Programs (in current dollars)



SOURCE: American Association for the Advancement of Science, *AAAS Report XII: Research and Development FY 1988* (Washington, DC: 1987)

X-RAY LASER HOLOGRAM PRODUCED

Using the Nova laser, scientists at LLNL have produced the world's first x-ray laser hologram. Previously, x-ray holograms were produced using synchrotron x-ray sources and required exposures of over an hour. This often produced blurred images of moving objects such as live cells. Laser x-ray holograms can be produced in fractions of a billionth of a second. Project leader Jim Trebes said "We believe this technology has the potential to produce three-dimensional images, with a resolution finer than 10 millionths of an inch, of live micro-biological specimens." The results of the experiments are described in the October 23, 1987 issue of Science. The x-ray laser holography is a spinoff of laser fusion technology. Participants in the research, in addition to Trebes, include Steven Brown, Gary Stone, David Whelan, David Nelson, Michael Campbell and Dennis Matthews.

SDI CHIEF SCIENTIST NAMED

Effective November 1, 1987, O'Dean Judd became Chief Scientist for the Strategic Defense Initiative Office in Washington. The post has been filled on an acting basis by Al Mense since the departure of Gerold Yonas a year ago. Judd was a scientific staff member at the Los Alamos National Laboratory for the past 15 years. Since 1981 at LANL he was responsible for evaluating programs involving high power lasers, particle beams, kinetic energy projectiles and nuclear directed energy. He holds a PhD in physics from UCLA.

FUSION BUDGETS

House-Senate conferees have proposed FY 1988 budgets of $335 million for magnetic fusion and $157 million for inertial fusion as part of the omnibus appropriations bill aimed at reducing the federal deficit. The action must still pass House and Senate and be signed by the President as part of an overall federal budget/deficit reduction package but such action will probably be complete by the time this newsletter reaches you.

The magnetic fusion number is $10 million below both the FY 1987 level and the FY 1988 Presidential request level. The inertial fusion number is $2 million above the FY 1987 level and $38.5 million above the FY 1988 Presidential request level.

TOMABECHI HEADS ITER MANAGERS

Ken Tomabechi of Japan has been named to head the team of "national managers" who will direct the quadripartite effort to design the International Thermonuclear Experimental Reactor (ITER). John Gilleland of LLNL will be the U.S. manager. Romano Toschi will be the European manager and Y. A. Sokolov will be the USSR manager. The managers group reports to the ITER council, headed by John Clarke of the USA. Other members of the ITER Council are J. Yamaji (Japan), C. Maisonnier (Euratom) and A. Vasileyev (USSR). A core design team from all four groups will work in Garching, FRG, with others working at national sites. The first phase of the 3 year study will begin in April and last 6 months.

FPA TECHNICAL REPORTS AVAILABLE

Results of Fusion Power Associates research programs are available to interested parties in limited quantities. The following is a partial list of reports we have that may be of special interest.

FPA-84-4 "HIBALL-II - An Improved Conceptual Heavy Ion Beam Driven Fusion Reactor Study" December 1984.

FPA-84-7 "Coriander: Comparison of Relevant Issues and Nuclear Development for Fusion Energy Research" June 1985.

FPA-85-3 "Z-Pinch - A Multifrequency Radiative Transfer Magnetohydrodynamics Computer Code" March 1985.

FPA-87-2 "Studies of a Modular Advanced Stellarator Reactor ASRA6C" May 1987.

FPA-87-3 "Possibilities for Breakeven and Ignition of D-He^3 Fusion Fuel in a Near Term Tokamak: Interim Report".

Copies of these reports may be requested from Dr. G. Kulcinski, Vice President, Research, Fusion Power Associates, 6515 Grand Teton Plaza, Madison, WI, 53706, (608) 833-3388.

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BUDGET UPDATE

Despite cutting the President's FY 1988 request for magnetic fusion from $345.6 million to $335.0 million, the Congress authorized the Compact Ignition Tokamak (CIT) as a line item construction project at Princeton. Eight million dollars was authorized to be spent between now and the end of September in addition to conceptual design activities funded in the operating budget. The action by Congress caught fusion managers by surprise since the Senate bill had not included the line item and most observers felt that it would be difficult to gain approval for the new project in the context of a reduction in the total magnetic fusion budget.

Congress added $40.5 million to the President's request for inertial confinement fusion, approving a total budget for the program of $159 million. This amount is about $4 million above last year's level. The bill specified that $2 million was provided "for preliminary design, engineering and development and related studies for the upgrade of the Omega Laser at the University of Rochester."

PRINCETON NAMES NEW DEPUTY

E. C. ("Tip") Brolin, a former Vice-President of Burns and Roe Enterprises, Inc. has been named Deputy Director for Technical Operations at the Princeton Plasma Physics Laboratory (PPPL). He will be responsible for the operation of the Laboratory's major magnetic fusion energy experimental projects including the Tokamak Fusion Test Reactor (TFTR) and the Princeton Beta Experiment (PBX-M). He will also be responsible for direction of the Engineering program, for all project support facilities and activities, and for the construction of the Compact Ignition Tokamak (CIT), scheduled for completion at PPPL in 1994.

PRINCETON DEPUTY DIRECTOR
E. C. ("TIP") BROLIN

Mr. Brolin's predecessors in this position were Dr. Don Grove, an outstanding fusion scientist who has worked at PPPL since 1954, and Mr. J. R. Thompson, Jr., who left the laboratory in October 1986 to become Director of NASA's Marshall Space Flight Center. Don Grove will continue to be active at the laboratory, carrying out special assignments utilizing his extensive experience in all aspects of the Laboratory's affairs.

Mr. Brolin worked in the Naval Nuclear Propulsion Program, under Admiral Rickover, and was responsible for design and construction of the NR-1, a nuclear-powered deep-submergence oceanographic research vessel. He joined Burns and Roe in 1974 and worked on a series of reactor and power plant projects. He left Burns and Roe in 1987 to start his own consulting practice.

ERAB TO REVIEW PRODUCTION REACTOR TECHNOLOGIES

A panel of the DOE Energy Research Advisory Board (ERAB) will review possible technologies for producing tritium for defense purposes. Congress recently approved $10 million in FY 1988 for preliminary design and engineering work for a new production reactor which, if eventually built, would replace "aging facilities" at the DOE Savannah River Complex in Aiken, South Carolina. DOE states, however, that there is no decision on where a new production reactor would be located.

DOE has indicated that the technologies it is considering are the high temperature gas-cooled reactor, the liquid metal reactor, the heavy water reactor and the advanced light water reactor. All the technologies being considered are fission reactors. Various groups have proposed to DOE that fusion reactors be considered for this purpose. Because fusion generates larger numbers of higher energy neutrons than fission reactors, a fusion reactor is a much more efficient producer of tritium. DOE considers fission reactors to be more reliable and is apparently unwilling to underwrite a fusion development program for this purpose.

The use of fusion reactors to generate tritium is the subject of two issues of the Journal of Fusion Energy (December 1986 and March 1987 issues). Furthermore, a study of this application was recently completed by the National Academy of Sciences in their report "Outlook for the Fusion Hybrid and Tritium-Breeding Fusion Reactor." Contact John Richardson and Bob Cohen at the National Research Council for further information (202) 334-3344.

Larry Papay, senior vice president of Southern California Edison Company, and a member of ERAB, will chair the ERAB panel.

REPORTS AVAILABLE

A review of current models that describe transport in tokamaks has been compiled by a group headed by Dave Ross of the University of Texas. Copies of the report (FRCR #295, June 1987) can be requested from Dave at (512) 471-4277.

A study entitled "Application of High Temperature Ceramic Superconductors to Commercial Tokamak Reactors" has been completed at Argonne National Laboratory. Copies of the report (ANL/FPP/TM-214, October, 1987) can be requested from Dave Ehst at (312) 972-4829.

A 20-page brochure entitled Fusion Energy: Meeting the Challenge" has been prepared by the Lawrence Livermore National Laboratory. It provides a nice overview of both magnetic and inertial fusion. Copies can be obtained from Fusion Power Associates (301) 258-0545.

BAKER HEADS MFAC PANEL

Magnetic Fusion Advisory Committee (MFAC) chairman Fred Ribe has appointed Argonne's Charlie Baker to head a panel to "review the long-range technology development for fusion." The study will include a review of requirements for advanced materials and nuclear technology, international collaboration in these areas and identification of high leverage technologies. A sixteen member panel has been assembled, which includes FPA president Steve Dean. The panel will hold its first meeting in early February and is to report back to MFAC by June 1988.

CRANDALL HEADS APP

Belatedly (with apologies) we announce that Dr. David H. Crandall was named Director, Division of Applied Plasma Physics (APP), Office of Fusion Energy, effective October 11, 1987. Dave had been Branch Chief for Experimental Plasma Research in APP since August 1983. He came to DOE from Oak Ridge National Laboratory after 15 years of experience in atomic physics and plasma diagnostic development. He is a fellow of the American Physical Society.

PEOPLE

Rich Mattas, Argonne National Laboratory, has been promoted to the position of Program Manager for the Blanket and Technology Program in the Fusion Power Program headed by Charlie Baker.

Joel Snow, Science/Technology Affairs Director in the Office of Energy Research, DOE, left DOE Jan. 22 to become associate vice president of research at Argonne National Laboratory and the University of Chicago (which operates Argonne).

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BALDWIN TO HEAD TEXAS INSTITUTE

David E. Baldwin has been named professor of physics and director of the Institute for Fusion Studies at the University of Texas at Austin. He succeeds Marshall Rosenbluth who has moved to the University of California at San Diego and GA Technologies. (See our August 1987 newsletter). Richard Hazeltine has been acting director since Rosenbluth's departure.

Baldwin has been deputy associate director of the magnetic fusion energy program at the Lawrence Livermore National Laboratory (LLNL). He has been at LLNL since 1970. His appointment to the Texas post was announced by Roger Bengtson, chairman of the physics department at UT Austin, who chaired the search committee.

"The first qualification we decided the new director had to have was to be a very good theoretical plasma physicst," said Bengtson. "He had to be connected with the fusion community and he had to have the ability to lead and work well with people. I would have to say that Dr. Baldwin exceeds those qualifications."

Hazeltine stated, "I would say that Baldwin's record of skillful management turned out to be the decisive factor. He's a proven scientific leader at a major fusion facility."

Baldwin received his Ph.D. from MIT in 1962 and, prior to 1970, held positions at Stanford University, Culham Laboratory and Yale University.

NUCKOLLS DESIGNATED LLNL DIRECTOR

The president and Regents of the University of California have designated John Nuckolls

DAVID BALDWIN

JOHN NUCKOLLS

to become the director of the Lawrence Livermore National Laboratory (LLNL) effective April 4. Nuckolls replaces Roger Batzel who has indicated his intention to retire. Nuckolls has been a long time leader of the weapons design effort, was a pioneer and continues to be an important contributor to inertial fusion research and policy. He was a recipient of Fusion Power Associates Leadership Award in 1982 and was a member of Fusion Power Associates Board of Directors from 1983 to 1986. We wish John success in this important position.

NEW TOKAMAK STUDY

Bob Conn of UCLA will direct a three year study of innovative design approaches for tokamak reactors. The study, known as ARIES, (Advanced Reactor Innovations Evaluation Study) began in February. The major study participants are: Argonne National Laboratory; the Fusion Engineering Design Center at ORNL; GA Technologies; Massachusetts Institute of Technology; Los Alamos National Laboratory; Princeton Plasma Physics Laboratory; and Rensselaer

Polytechnic Institute. International participation is expected from Canada, Europe and Japan.

A similar study (called TITAN) for the reversed field pinch, also headed by Conn, was recently completed (see our January newsletter).

ARIES will have two phases. In Phase I, which will last about a year, the team will concentrate on concept development, innovative proposals, and assessment of major physics and technology advances and innovations in tokamak reactor designs. In Phase II, the concepts that appear most promising will be selected for further development into several "conceptual" tokamak fusion reactor designs.

Among the key experimental and theoretical advances that will be considered in ARIES are: MHD beta limits, confinement and transport (e.g., H-mode and pellet fueling), current-drive theory and demonstration (e.g., rf current drive and bootstrap), and impurity control systems (divertors and pump-limiters).

1988 BUDGET UPDATE

In passing the final FY 1988 budget for DOE, congress (1) added $13M to the President's request for Nuclear Energy R&D, primarily for Advanced Reactor R&D, including the HTGR; (2) provided the full amount requested ($803M) for General Science and Research, including $25M for SSC R&D but no money for construction; (3) added $40.5M to the President's request for inertial confinement fusion; (4) cut $10M from the request for magnetic confinement fusion but allowed $8M for proceeding with engineering design (Title I) for the Compact Ignition Tokamak construction project, and (5) cut $341M from the request for Defense Activities. Details are given below.

	$M	
	Pres. Request	Final Appro.
Activity		
Nuclear Energy	$334.17	$347.02
General Science	802.70	802.70
Magnetic Fusion	335.00	345.60
Inertial Fusion	118.50	159.00
Defense Activities	7931.50	7590.36

1989 BUDGET

President Reagan has sent to Congress his 1989 budget request. For magnetic fusion $360M is requested compared to $335M appropriated in FY 1988. For inertial fusion $163.7M is requested, compared to $159M appropriated in FY 1988. Further breakdown of the magnetic fusion totals, including an OMB-approved 5-year plan, are given in the Table on page 4. The budget requests construction authorization of $426M for the Compact Ignition Tokamak on a stretched-out schedule leading to completion in 1996.

HEAVY ION FUSION PAPERS

A collection of recent papers on the status of Heavy Ion Fusion research has been published as a dedicated issue of the ANS journal Fusion Technology (Vol. 13, No. 2, February 1988) under the guidance of special issue editor Don Dudziak of Los Alamos. The papers mostly are based upon talks presented at the June 1986 ANS Seventh Topical Meeting on the Technology of Fusion Energy. A limited number of copies of this special issue may be available by calling Don Dudziak at (505) 667-6336. Another good source of recent information is AIP Conference Proceedings 152, "Heavy Ion Inertial Fusion" (1986) available in book form from the AIP, 335 E. 45th Street, New York, NY, 10017. An 8-page brochure on this subject is also available from Denis Keefe (415) 486-6376.

APS ELECTS FELLOWS

Our congratulations to the following members of the APS Division of Plasma Physics who have recently been elected as Fellows of the American Physical Society.

Manfred Bitter (PPPL)
Morrell S. Chance (PPPL)
Bruce I. Cohen (LLNL)
Gerald Cooperstein (NRL)
Nathaniel J. Fisch (PPPL)
Robert J. Goldston (PPPL)
Allan A. Hauer (LANL)
Donald A. Gurnett (U. of Iowa)
Daniel L. Jassby (PPPL)
Kenneth Lee (LANL)
Robert G. Littlejohn (UC/Berkeley)

Neville C. Luhmann, Jr., (UCLA)
Earl S. Marmar (MIT)
William C. Mead (LANL)
Ronald D. Stambaugh (GA Technologies)
Henry R. Strauss (NYU)
Edward A. Williams (LANL)

NEW FUSION BROCHURES

A colorful, new 23-page brochure, entitled "Fusion in Our Future" has been published by GA Technologies. The brochure was edited by Ken Schultz and Bob Bourque of GA Technologies and Ralph Moir of Lawrence Livermore National Laboratory. It describes 8 potential uses of fusion in the future: electric power, medicine and health technologies, food preservation, fissile fuel production, synthetic fuels and process heat, defense technology, rare metal transmutation and space propulsion and power.

An 8-page brochure entitled "The Compact Ignition Tokamak: An Overview" is available from Princeton Plasma Physics Laboratory (609) 683-2750.

BOGART JOINS GENERAL DYNAMICS

Longtime fusion researcher Locke Bogart (no relation to Humphrey) has joined General Dynamics Corp. in their Laser Systems Laboratory where he will oversee defense laser technologies. Just prior to joining GD, Locke completed a study for DOE entitled "Assessment of the Implications of the Development of High Performance Superconductors on the Prospects for Magnetic Fusion Energy." Copies are available from Locke on request. He can be reached at General Dynamics Laser System Laboratory, 5452 Oberline Drive, San Diego, CA, 92121, (619) 457-3155.

CORNELL RESEARCH SUMMARY, PART 2

The Winter 1987-88 issue of Engineering, a Cornell University quarterly provides Part 2 of a series of articles describing plasma physics research at Cornell (see our November 1987 newsletter). This issue includes articles by Richard Lovelace on "Black-Hole Pumps," by Charles Wharton on "Intense Relativistic Electrons," by Hans Fleischmann on "Compact-Toroid Fusion and High-Energy Particle Rings," and by Bruce Kusse on "Inertial Confinement Fusion." Copies of part 1 (Autumn 1987 issue) or part 2 can be requested from David Hammer, Director, Laboratory for Plasma Studies, Cornell University, Ithaca, NY, 14850, (607) 255-3916.

PEOPLE

Nick Krall has left JAYCOR to form his own consulting business called Krall Associates. Nick can be reached at 1070 America Way, Del Mar, CA, 92014, (619) 481-7827.

Alex Glass has left KMS Fusion to form his own consulting business. Alex can be reached at 206 Hillcrest Rd., Berkeley, CA, 94705, (415) 652-6165.

Tom Simonen has left LLNL to become director of the DIII-D program at GA Technologies.

MEETINGS

March 13-17 Seventh Topical Conference on High-Temperature Plasma Diagnostics. NAPA, CA. Contact Lynette Lombardo (213) 825-3209.

April 10-19 International Symposium on Fusion Nuclear Technology. Tokyo. Contact Mohamed Abdou (213) 206-1228 or Kenzo Miya. Telex 2722111 FEUT J.

April 18-20, 1988 Sherwood Theory Conference. Gatlinburg, TN. Contact Gail Hamilton (615) 574-1145.

April 25-29 CLEO '88 OSA/IEEE Conference on Lasers and Electro-Optics. Anaheim. Contact OSA (202) 223-8130.

May 1-6 Third Topical Meeting on Tritium Technology in Fission, Fusion, and Isotopic Applications. Toronto. Contact C. Burnham (416) 823-6364.

May 31-June 3 The 32nd International Symposium on Electron, Ion and Photon Beams. Fort Lauderdale, FL. Contact Evelyn Hu (805) 961-2369.

June 5-10 Second International Congress on Energy. Tiberias, Israel. Contact International Ltd., 12 Shlomzion Hamalka St., 94, 146 Jerusalem, Israel.

June 6-8 Fifteenth IEEE International Conference on Plasma Science. Seattle. Contact Loren Steinhauer (206) 827-0460.

MFE OUTYEAR BUDGETS/(ESCALATED DOLLARS)
(dollars in millions)

	FY 1988	FY 1989	FY 1990	FY 1991	FY 1992	FY 1993
Compact Ignition Tokamak Total	15.5	27.0	46.0	64.0	95.0	101.0
Tokamak Fusion Test Reactor	72.1	74.3	83.0	79.0	45.0	42.0
Total Ignition	(87.6)	(101.3)	(129.0)	(143.0)	(140.0)	(143.0)
Princeton Beta Exp	11.1	11.4	-	-	12.0	13.0
Alcator C-Mod Ops	5.2	10.6	12.0	16.0	17.0	17.0
Alcator C-Mod MDF	4.9	4.9	4.0	-	-	-
Adv. Toroidal Fac.	18.1	18.0	19.0	19.0	20.0	21.0
DIII-D	29.7	32.5	33.0	35.0	46.0	48.0
Microwave Tokamak Exp. Ops	3.2	10.5	10.0	11.0	-	-
Microwave Tokamak Exp. MDF	6.1	-	-	-	-	-
International/Other	7.2	6.6	6.0	7.0	8.0	8.0
Mirrors	3.6	3.0	3.0	-	-	-
Conf. Systems Total	176.7	198.8	216.0	231.0	243.0	250.0
Plasma Tech	16.2	14.9	16.0	15.0	16.0	16.0
Fusion Tech	21.1	21.6	21.0	21.0	21.0	24.0
Systems Design	2.6	2.3	2.0	2.0	2.0	2.0
Intl. Thernomuclear Exp. Reactor**	16.0	16.0	16.0	17.0	18.0	19.0
Cap Equip	2.5	3.5	2.0	2.0	2.0	2.0
Dev. & Tech. Total*	58.4	58.3	57.0	57.0	59.0	63.0
Reversed Field Pinch	12.4	15.3	16.0	16.0	17.0	18.0
Comp. Toroids	9.8	9.6	8.0	8.0	8.0	9.0
Exp. Plasma Res.	15.8	16.2	18.0	19.0	19.0	20.0
Theory	18.6	18.8	19.0	20.0	20.0	22.0
Computing	18.1	18.3	16.0	15.0	16.0	16.0
Cap. Equip.	3.3	2.4	2.0	2.0	2.0	2.0
Applied Plasma Physics*	78.0	80.6	79.0	80.0	82.0	87.0
General Plant Projects/ General Purpose Equip./ Program Direction	21.9	22.3	23.0	24.0	25.0	26.0
Office of Fusion Energy Total	335.0	360.0	375.0	392.0	409.0	426.0

* Basic R&D in support of the CIT program will be continued, as appropriate.

**Conceptual design report for ITER to be completed in 1990; Outyear projections include level of effort, no construction.

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PARKER TO HEAD MIT CENTER

Ron Parker, head of the highly successful Alcator group at MIT, has been named Director of the MIT Plasma Fusion Center, effective July 1. Parker will succeed Ron Davidson who had previously indicated his intention to vacate the post in order to devote more time to teaching and research (see our October 1987 newsletter). In an independent action, Parker was also named to the National Academy of Engineering.

Among his many accomplishments Parker was responsible for consistently demonstrating the highest values of density-confinement time (Lawson) product in the Alcator series of experiments. These experiments have provided the basis for the design of the Compact Ignition Tokamak (see our February 1988 newsletter).

NEW MIT PLASMA FUSION CENTER DIRECTOR, RON PARKER

ATF OPERATION

The Advanced Toroidal Facility (ATF), a major new, $29 million U.S. fusion experiment at Oak Ridge National Laboratory, has achieved "first plasma" operation. The device is of the "stellarator" type, first invented in the U.S. by Lyman Spitzer in the early 1950's, but more recently pursued primarily in Europe and Japan. ATF is the first new stellarator to be built in the U.S. in 20 years.

According to Michael J. Saltmarsh, head of the confinement projects section in ORNL's Fusion Energy Division, "ATF should help us understand the physics of this class of magnetic confinement devices, which includes the more commonly studied tokamaks. Our goal is to contribute to the development of toroidal fusion devices, based on tokamaks and stellarators, that will be reliable and economical sources of electrical power."

Unlike the tokamak, which relies on a pulsed plasma current for containment, a stellarator such as the ATF uses only externally applied magnetic fields to confine the plasma. Therefore, a stellarator can be operated continuously.

ATF represents the largest of the four major stellarator devices currently in operation throughout the world-including Heliotron-E (Japan), Wendelstein VII-AS (West Germany), and URAGAN (USSR). ORNL maintains productive collaborations with these countries as well as with U.S. universities in many areas of stellarator design and operation.

The manufacturers of the major components were Chicago Bridge and Iron Co. (helical coils), Princeton Plasma Physics Laboratory (poloidal coils), Pittsburgh Des Moines Steel Corp. (vacuum vessel), and Westinghouse Electric Corp. (structural shells).

NEW BOOK BY FREIDBERG AND HUTCHINSON

Two new books of interest to fusion researchers have just been published. Ideal Magnetohydrodynamics by Jeff Freidberg is a graduate level textbook. It covers both the equilibrium and stability aspects of confinement systems, and provides a systematic treatment of this important aspect of magnetic confinement theory. It is published by Plenum Press.

Principles of Diagnostics, by Ian Hutchinson is also at the graduate level, and, like Freidberg's book, is an outgrowth of a course taught at MIT. It provides a systematic introduction to the physics on which plasma diagnostics are based and thus serves both as a vehicle for entering students and as a reference for experienced researchers. It is published by Cambridge University Press.

REPORTS AVAILABLE

Richard F. Post of LLNL has published an outstanding 200-page review article of the physics and technology of "The Magnetic Mirror Approach to Fusion." The article documents our knowledge based on 30 years of research on magnetic mirrors. The article appears in Nuclear Fusion 27, 1579 (October 1987). Reprints can be obtained from Dick at (415) 422-9853.

The University of Rochester Laboratory for Laser Energetics has published its 1987 Annual Report. The report documents the achievement of compression of DT fuel in glass microspheres to densities of about 50 times liquid density. (Recently the group reported achieving densities of over 100 x liquid density.) Copies can be obtained from Bob McCrory at (716) 275-4973.

KMS Fusion has published a brochure describing its capabilities in the field of space technology. Copies can be obtained from Harold N. Davis, director of marketing (313) 769-8500.

A colorful 23-page brochure entitled "Fusion in Our Future" (see our March newsletter) can be obtained from Fusion Power Associates.

EARLY MICROWAVE FEL TESTS PLANNED AT LLNL

LLNL is planning to accelerate the time scale for results of intense microwave heating in the rebuilt Alcator C tokamak (now called MTX) by using the wiggler and beamline components from the former Electron Laser Facility (ELF). This system was used with the ETA-I accelerator (dismantled last year) to efficiently generate 2 GW pulses of microwaves at 35 GHz, and later to amplify 140 GHz signals to the 100 MW level. For early MTX experiments, the ELF system will be used with ETA-II, the new 6 MeV high repetition rate accelerator now operational in the Beam Research Program at LLNL.

Although limited by the short-pulsed wiggler magnet of ELF to operation with single FEL pulses, the expected power levels of 2-3 GW at 140 GHz will permit early tests in MTX of nonlinear propagation and absorption theories. With the reduced funding levels imposed on the MTX Program by the FY 88 budget cuts, FEL heating experiments with new beamline components and a new steady-state wiggler system were projected to slip into FY 90. With the ELF system however, installation of these old components can be completed this year and experiments begun early in FY 89. Meanwhile construction of the full 250 GHz, 2 MW average power system is proceeding on a slower schedule. Contact Keith Thomassen at LLNL for details (415) 422-1166.

MEETINGS

May 1-6 Third Topical Meeting on Tritium Technology in Fission, Fusion, and Isotopic Applications. Toronto. Contact C. Burnham (416) 823-6364.

June 6-8 Fifteenth IEEE International Conference on Plasma Science. Seattle. Contact Loren Steinhauer (206) 827-0460.

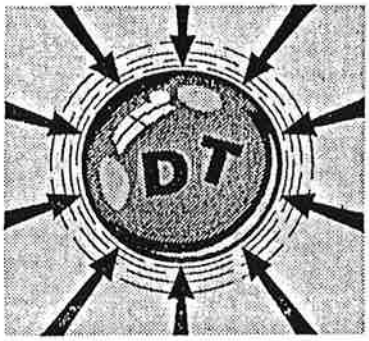
June 28-30 International Symposium on Heavy Ion Inertial Fusion. Darmstadt, FRG. Contact Prof. R. Bock, GSI, Postfach 110552, D-6100 Darmstadt, FRG. Telex 419593.

"All the News That's Fit to Print"

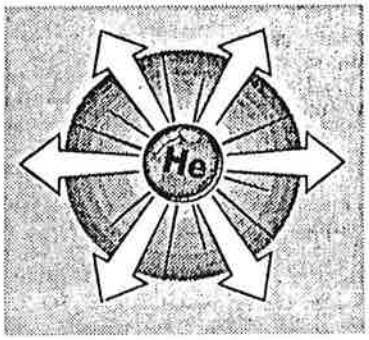
The New York Times

VOL.CXXXVII.... No. 47,451 MONDAY, MARCH 21, 1988

A Step Toward Harnessing Fusion Energy



In a successful secret experiment, deuterium and tritium isotopes of hydrogen in a tiny pellet were bombarded with X-rays from an underground nuclear bomb test, heating and compressing them to great density.



The isotopes fused, producing helium and a burst of nuclear energy, identical to reactions in the sun and hydrogen bombs. The method has no practical use, but might help determine how fusion energy can be harnessed.

Source: Department of Energy

The New York Times/March 21, 1988

Secret Advance in Nuclear Fusion Spurs a Dispute Among Scientists

By WILLIAM J. BROAD

In top-secret experiments, Federal researchers have achieved one of the nation's most costly and elusive scientific goals: to ignite a nuclear fusion reaction in tiny pellets of hydrogen, producing powerful bursts of energy.

The success was achieved in unorthodox experiments some two years ago at the Government's underground nuclear test site in the Nevada desert, according to Federal scientists and officials, who spoke on the condition of anonymity. The results have triggered a bitter dispute over how the field of small-scale fusion should progress.

For decades, hundreds of American scientists have sought to tame nuclear fusion at a cost of more than $2 billion. Advocates say the technique, if perfected, could be used by the 1990's to study nuclear physics, to develop antimissile weapons and, perhaps in the next century, to generate cheap, almost limitless electrical power.

Advance Viewed as Crucial

Although the secret ignition was achieved with a method that has no practical use, it is viewed as a crucial advance that will help determine the feasibility of harnessing small-scale fusion.

The secret ignition was attained in a departure from the nation's main strategy, which has attempted, without success, to use beams of concentrated light from giant laboratory lasers to ignite the reaction. Instead, fusion in tiny fuel pellets was triggered by a blast of radiation from an exploding nuclear weapon. Such secret experiments, which are believed to have never before been publicly disclosed, were conceived more than a decade ago as a way to assess the feasibility of the field, which is known as microfusion.

Some prototype fuel pellets, glass capsules filled with hydrogen isotopes, are so small that a dozen can easily fit on the head of a pin. Their power output could be equivalent to up to hundreds of pounds of high explosive.

In the fusion reaction, atoms are joined together to release the kind of energy that powers the stars and hydrogen bombs. In nuclear fission, by contrast, heavy atoms such as uranium are split apart to power atom bombs and nuclear reactors. The key question in microfusion is its practicality.

To the surprise of experts, the secret achievement in the Nevada desert required more energy than expected, triggering a clash among Federal scientists and Government officials over how to advance the $160 million-a-year field. Disclosure of the result is also likely to encourage critics outside the Government who charge that microfusion is too formidable to ever be practical.

In the dispute, some scientists now assert that the nation's laser-based microfusion program needs a radical change of course in order to insure success. Other scientists vigorously disagree, saying the nuclear test was an unconventional but vital milestone that has demonstrated microfusion's feasibility and generated valuable data that will help make it practical.

Despite the discord, the secret success has generally elated fusion scientists who know of it.

In a tantalizing, little-noticed statement last September, Sheldon Kahalas, director of the nation's microfusion effort, run by the Federal Department of Energy, told a Princeton University conference that a top-secret effort code named Centurion-Halite had achieved results that marked a "historical turning point" for the fusion program. In response to questions, he refused to elaborate and he did not mention the role of underground nuclear tests.

However, he and other scientists at the Princeton conference said the nation was ready to start planning a full-scale laboratory microfusion facility, which they estimated would cost between $500 million and $1 billion.

"There's a new sense of excitement," William J. Hogan, a microfusion official at the Lawrence Livermore National Laboratory in California, said in an interview. "In the last two years, we've gotten almost all the data we wanted. That's remarkable. We kind of startled ourselves."

Scientists and officials quoted by name in this article spoke freely about the dispute and some of the implications of the secret tests, but they declined to discuss how the classified experiments were done. In general information concerning nuclear weapons and their design is classified secret because the Government wants kept such information which can have military uses out of foreign hands.

A Long Quest to Create Tiny Man-Made Suns

For decades, one of the fondest hopes of science has been constructive control of the energy of nuclear fusion, to create tiny, man-made suns. These miniature fireballs could be anywhere from hundreds of thousands to millions of times smaller than hydrogen bombs, making them tame enough for use in laboratories and reactors.

From modest beginnings in the early 1960's, the microfusion idea has grown into a sizable Federal program centered at the Government's main laboratories for the design of nuclear weapons: the Livermore laboratory in California and the Los Alamos National Laboratory in New Mexico. Both belong to the Energy Department.

The main approach to microfusion has been to try to ignite fuel pellets with powerful lasers, although generations of lasers have come and gone with no consensus developing on what is the best kind. To reach ignition, a tiny glass sphere filled with deuterium and tritium, isotopes of hydrogen, must be compressed to very high densities and heated to almost 100 million degrees Celsius, several times the temperature at the center of the sun. So stressed, it would undergo rapid thermonuclear reactions, fusing hydrogen into helium and giving off bursts of energy.

To lessen the difficulty of focusing multiple laser beams on a minuscule target, weapons scientists surround the fuel pellet with a metal case that converts coherent laser light into X-rays, which compress the target with great uniformity.

Despite considerable effort, no ignition has been achieved with these methods. The main problem has been lack of sufficient laser energy.

Today the nation's most energetic microfusion laser is Livermore's Nova, a $200 million device bigger than a football field whose 10 beams can bombard a fuel pellet with some 100,000 joules of energy. A joule is roughly the energy of a flashlight switched on for one second.

In March 1986, an expert panel of the National Academy of Sciences said the energy needed for pellet ignition might prove to be as high as 10 million joules. It said an additional uncertainty was the minimum mass of fuel needed to achieve ignition.

In concert with such publicly known efforts and estimates, a top-secret Federal program, conducted jointly by Livermore and Los Alamos, has been underway for at least a decade to achieve microfusion ignition by harnessing the output of nuclear weapons, which can produce radiation more powerful than any laser's. The main output of nuclear weapons are X-rays, which are directed at the tiny fuel pellets.

Critics agrue small-scale fusion poses formidable problems.

Scientists Race to Design Full-Scale Laser Facility

After years of failures, the program achieved its initial success at ignition some two years ago, Federal scientists and officials said. What surprised some of them was how much energy it took, and how relatively large the tiny fuel pellets had to be in order to achieve ignition.

The exact numbers of both the amount of energy required and the size of the pellets are secret. But the energy needed for a laboratory laser to mimic the classified achievement would be in the range of 100 million joules, or ten times what the National Academy of Sciences said might be necessary, experts familiar with the experiments said. Moreover, subsequent nuclear tests at lower energy levels failed, although some Federal scientists are confident these will eventually succeed.

The data sent scientists racing to design a full-scale laser facility. So too, the Energy Department last year began to plan what it calls a Laboratory Microfusion Facility.

But the nuclear success has triggered a bitter clash over how to achieve microfusion. At issue is whether to press ahead with lasers and targets in the range of five to 10 million joules, or to shift to include lasers big enough to mimic the conditions of the underground achievement. Experts agree that the current generation of microfusion lasers are unsuited for producing such high energies, the cost being prohibitive.

At Los Alamos, secluded high in the mountains of New Mexico, two physicists have championed the high-energy approach and won favorable review from eight colleagues appointed to evaluate its merits. But the laboratory's senior management, saying budgets are too tight to pursue the novel and unproven scheme, has ordered work on it to cease and has laid off one of the two scientists.

The aim of the disputed idea is to build a giant laser running on hydrogen and fluorine gas. These chemicals combine explosively, much like rocket fuel, producing heat and light that can be converted into laser beams. Indeed, hydrogen-fluoride lasers are common. The novel twist, which has undergone some testing, is to extract the chemical energy very rapidly, in billionths of a second, by triggering its combustion with intense beams of electrons. In theory, such a laser, if large enough, could deposit 100 million joules of energy on a target.

The scientists behind the idea, P. Leonardo Mascheroni and Claude R. Phipps, said it deserved serious study and suggested that resistance to it stems from an over zealous commitment to the status quo. "It's a cultural thing," said Dr. Mascheroni, a native of Argentina who was recently laid off after nine years at Los Alamos. "They don't want to admit something different."

Los Alamos officials said budget cuts have forced many layoffs, and that Dr. Mascheroni's ideas have been found wanting. "There was nothing so compelling that we thought we should drop the approach we're taking now," said John E. Browne, head of defense programs at Los Alamos.

Despite official resistance, the hydrogen-fluoride proposal was favorably reviewed by an eight-person Los Alamos panel chaired by Gregory H. Canavan, a respected senior scientist who formerly headed the Energy Department's microfusion effort. After deliberating two months, the Canavan panel in February 1987 recommended that four to six scientists work on the idea for a year. The fundamental attraction, the panel said, was that the giant laser, if found feasible, would be 10 to 20 times cheaper to build than conventional rivals pushed to the 100-million-joule range. The success of the venture, it concluded, "could bring the energies that may be required for fusion experiments."

Current Effort Defended Despite the Problems

Today, Los Alamos says the idea's merits are not great enough to divert scarce funds from the laboratory's current microfusion effort, which centers on a $60 million krypton-fluoride laser that to date has generated only 25 joules. Although the laboratory admits the laser has problems, it says the device will eventually produce 10,000 joules.

Moreover, Federal scientists in charge of microfusion said ignition would be achieved at energy levels far below 100 million joules, based on calculations derived from secret tests.

"We view that classified data as saying you don't have to have as much of a driver as people thought," said Dr. Hogan of the Livermore laboratory, adding that the data "pretty well confirms our opinion" that five to ten million joules are sufficient to achieve ignition.

At Energy Department headquarters, Dr. Kahalas, director of the national program, defended the laser efforts at Los Alamos as "reasonable" and at Livermore as "excellent." He added that if higher-energy drivers were ever deemed necessary, other candidates would probably be considered in addition to hydrogen-fluoride lasers.

Weapons scientists agree that microfusion could be used to study the physics and effects of nuclear weapons, to perfect nuclear-powered antimissile arms such as the X-ray laser, and to power futuristic reactors to generate electricity.

Dr. Mascheroni, the former Los Alamos physicist, argued that the field was so important that the nation needed an insurance policy in case the conventional wisdom was wrong. He said he hoped the dispute would trigger a new National Academy of Sciences review of microfusion, and a Congressional inquiry into the field's management.

But an Energy Department official insisted that the program was healthy and showing considerable promise.

"It has had what I would call an enormous success," said Dr. Kahalas, director of the national effort. "There's no way I can tell you about a classified program. But we think we're very close to showing this thing is feasible."

EXECUTIVE NEWSLETTER

MAY 1988

FUSION POWER ASSOCIATES

2 PROFESSIONAL DRIVE, SUITE 248 • GAITHERSBURG, MARYLAND 20879

(301) 258-0545

FPA FINANCES

	1987	1986	1985
Income			
Research	$155,293	$189,938	$201,476
Dues	79,021	90,955	108,891
Other	50,927	52,576	66,751
Total	$285,241	$333,469	$377,118
Expenses			
Research	$161,350	$189,944	$201,333
Education	54,615	47,204	80,464
Admin.	68,578	73,396	96,037
Total	$284,543	$310,544	$377,834
Assets			
Net Cash	(4,105)	7,469	(4,575)
Equity	26,180	28,657	17,776
Engineering Prize Fund	5,496	4,270	n/a

EUROPE PLANS AMBITIOUS FUSION PROGRAM

Europe is planning an ambitious fusion program for the next five year period according to Wim Van Deelen, counselor for science and technology at the European Community's (E.C.) Delegation in Washington, D. C. Writing in the March 1988 issue of Europe Magazine, Van Deelen states that "In absolute terms, overall expenditure for fusion research in the E.C. during the period 1987-91 is expected to be about $2.3 billion European Currency Units, or on the average, about $580 million per year at current exchange rates." The U.S. has planned to spend about $360 million per year during the same period (see our March 1988 newsletter.) The European strategy is laid out in the so-called "Framework Program" which covers a wide range of European research and development activities, not just fusion. According to Van Deelen, "The Framework Program also defines the relative priorities in terms of financial support" among the various disciplines. Energy research accounts for 22% of the resources; within energy, 52% is earmarked for fusion. In the U.S. 70% of government R&D is for defense. Of the civilian R&D, 12% is for energy; within energy, 16% is earmarked for fusion. Copies of Van Deelen's article are available from Fusion Power Associates.

PEOPLE

Don Kerst has been awarded the Robert R. Wilson prize by the American Physical Society, "for his many contributions to accelerator physics, including the invention of the betatron (1940); his seminal paper (with Serber) on orbit dynamics in circular accelerators (1941); his leadership in the design and construction of a series of machines at the University of Illinois (through 1950); and his work as Technical Director of the Midwestern Universities Research Association (1953-1957) from which came, from his own work and from his stimulation of others, many of the most important accelerator physics developments of the 1950's.

Don was a recipient of Fusion Power Associates' Distinguished Career award in 1987.

John W. Landis, Senior Vice President and a Director of Stone and Webster Engineering Corp., has been awarded the Winston Churchill Medal of Wisdom by the Wisdom Society. The medal is given to individuals who have made "notable contributions to solution of a broad range of societal problems" and who have demonstrated "superior intelligence, high idealism and productive application of talent." Landis is a past chairman and current member of the Fusion Power Associates Board of Directors.

DOE has appointed three new members to the Magnetic Fusion Advisory Committee. They are Everett Bloom of ORNL, Wilhelm Gauster of Sandia National Laboratories (Albuquerque) and Tihiro Ohkawa of GA Technologies.

REPORTS AVAILABLE

John Sheffield has published an article entitled "Magnetic Fusion Progress: A History and Review" in the latest issue (No. 4, 1987) of the Oak Ridge National Laboratory Review. The 13-page article shows the rapid anticipated world demand for energy by 2050, has many diagrams describing plasma phenomena and discusses progress and critical issues for tokamaks. The same issue of the "Review" describes the international large (superconducting) coil facility and the new Oak Ridge stellarator. Copies can be requested from John at (615) 574-1145.

Two recent reports by FPA president Steve Dean can be requested from Fusion Power Associates. One is a reprint from the Journal of Fusion Energy (Vol. 7, No. 1, 1988) entitled "Commercial Objectives, Technology Transfer and Systems Analysis for Fusion Power Development." It is the material prepared for inclusion in the DOE Technical Program Analysis activity. The second is a preprint of an article to be published in the September 1988 issue of the Journal of Fusion Energy. It is entitled "Impact of High Temperature Superconductors on the Possibility of Radio-Frequency Confinement."

FPA ANNUAL MEETING AND SYMPOSIUM, SEPT. 6-8

Fusion Power Associates will hold its annual meeting and symposium September 6-8 in Santa Fe, New Mexico. The theme of the symposium will be "Creating Compact, High Power Density Fusion Plasmas." The meeting will include tours of fusion facilities at Los Alamos National Laboratory and Sandia National Laboratories (Albuquerque). Details of the meeting will be forthcoming in a separate mailing.

ITER DESIGN STARTS

The ITER design team has begun work in Garching, West Germany,. The team includes the team leader, Japan's Ken Tomabechi, John Gilleland for the U.S., Romano Toschi for the Europeans, and Y. A. Sakolov for the USSR. The team will report to the ITER Council headed by John Clarke. Japan's J. Yamaji, Euratom's C. Maisonnier and the USSR's A. Vasileyev are the other council members.

In addition to Gilleland, the U.S. is sending a ten-person team to Garching for the period May 3-September 15. They are Carl Henning, John Perkins, Bill Nevin and Walt Lindquist from LLNL; Chuck Flanagan, David Lousteau and Paul Fogarty of Oak Ridge; Sam Cohen and Doug Post of Princeton and Charlie Baker of Argonne.

TWINING NAMED ALOO MANAGER

Bruce Twining has been named manager of the DOE's Albuquerque Operations Office. Since last September he has been the Deputy Assistant Secretary of Energy for Nuclear Materials Production and prior to that was deputy manager of the DOE's Savannah River Office. The fusion community will remember Bruce as the DOE project manager for the Mirror Fusion Test Facility and as a member of the Systems Branch in the Office of Fusion Energy.

MEETINGS

June 28-30 International Symposium on Heavy Ion Inertial Fusion, Darmstadt, FRG. Contact Prof. R. Bock, GSI, Postfach 110552, D-6100 Darmstadt, FRG. Telex 419593.

July 4-7 BEAMS '88, Seventh International Conference on High-Power Particle Beams, Karlsruhe FRG. Contact Prof. Dr. G. Kessler, P.O. Box 3640, D-7500 Karlsruhe 1, FRG, Tel. (07247) 82-2440; Telex 7826484 kfk d; Telefax (07247) 82-5070.

August 21-25 Applied Superconductivity Conference. Sheraton Palace Hotel, San Francisco. Contact Dr. Carl Henning, L-644, LLNL, Livermore, CA 94550 (415) 422-0235.

Sept. 6-8 Fusion Power Associates Annual Meeting and Symposium on "The Creation of Compact, High Power Density Plasmas," Santa Fe. Contact Ruth Watkins (301) 258-0545.

Sept. 7-8 Magnetic Fusion Advisory Committee Public Meeting, Los Alamos. Contact Fred Ribe (206) 543-0355.

Sept. 19-23 APS Topical Conference on Plasma Astrophysics. Santa Fe. Contact Sheron Trujillo (505) 667-8366.

DOE HONORS ABDOU, BAKER, CALLEN AND DEAN

Secretary of Energy John S. Herrington has designated Mohamed Abdou (UCLA), Charles Baker (ANL), James Callen (U. Wisconsin), and Steve Dean (Fusion Power Associates) as DOE "Distinguished Associates." The awards are presented to DOE contractor employees "for outstanding individual efforts or achievements." It is the highest departmental award which can be presented to DOE contractor employees. The awards cite each of the four separately for their "exceptional leadership of the Technical Program Analysis activity," stating that the study "will serve as a solid foundation for both long-term planning in the U.S. Magnetic Fusion Energy Program, as well as for international negotiations toward world-wide collaboration in fusion." The awards were presented by Dr. John F. Clarke on behalf of the Department.

DOE Distinguished Associate Mohamed Abdou of UCLA who was unable to attend the awards ceremony (below).

DOE Office of Fusion Energy head John Clarke (right) and his deputy N. Anne Davies (left) present DOE Distinguished Associate Awards to (l to r) Charles C. Baker, Stephen O. Dean, and James D. Callen.

CONGRESSIONAL TESTIMONY*

DR. STEPHEN O. DEAN
PRESIDENT
FUSION POWER ASSOCIATES

The effort to develop a fusion energy source has two important and equally essential parts. The first is, in the near term, to demonstrate fusion plasma conditions of density, temperature and confinement time close to what is required in a fusion reactor. This effort includes developing the necessary technology and understanding for those near-term achievements. The second important and essential element of fusion development consists of those programs required to ensure that fusion will be useful for some practical purpose in the long-term. These programs include concepts and concept improvements whose environmental, safety and economic features will make fusion a winner in comparison with competing technologies. Such efforts include the necessary systems studies and analysis, materials and technology development, new concept experiments, and fundamental physics and engineering research at national laboratories, industries and universities.

Maintaining the necessary balance between these essential near-term and long-term aspects of fusion development has become especially difficult for both the magnetic and inertial fusion programs because of the decline of their budgets in recent years and the flat funding projections of the next several years.

In magnetic fusion, the near-term program consists primarily of the TFTR and CIT tokamak programs at Princeton, other large tokamak experiments, notably the DIII-D at GA Technologies and the Alcator program at MIT, and supporting theory and technology efforts. I would also include in this catagory the ITER design effort, although its payoff might well be catagorized as "mid-term." These programs are clearly essential to fusion progress and deserve a certain degree of priority in allocating funds.

It is unfortunate that the funding projected to be available for the CIT project does not permit it to be built expeditiously. As I warned in my testimony last year, "Unless substantial increases are provided in FY 1989, I would anticipate schedule slippages and project cost increases." The budget submitted does not provide the increases required for expeditious completion either for CIT or for several other projects, notably the CPRF at Los Alamos and the Field Reversed experiment at Spectra Technology.

Of more concern than the FY 1989 submission however, are the out-year projections. The OMB and DOE appear to have agreed on a 5-year projected flat budget profile that, if implemented, not only results in delays and cost increases for CIT but also spells disaster for many, if not most, of the programs required for the success of fusion in the long-term.

Systems studies, necessary for guiding the magnetic fusion program toward practical products, are projected to decline to a paltry $2 million per year. These studies include the investigation of concepts and fuel cycles that would impact the environmental, safety and economic characteristics of fusion devices. Also, a recent subpanel of the Magnetic Fusion Advisory Committee recently warned in its interim report that the program currently in place and projected would not result in sufficient data by the year 2005 to permit an assessment of the environmental, safety and economic aspects of fusion to be made nor to allow a fusion demonstration reactor to be built using low-activation materials.

It is not unreasonable to ask the long-term payoff portions of the fusion program to tighten their belts a little in FY 1989 to help launch a major new near-term project like CIT. It is unreasonable, however, for the executive and legislative branches to expect to build a $400 million new facility without providing new money for a substantial fraction of its cost. A new project of this magnitude requires some real budget growth. This program is not too acute in FY 1989 but will become very acute in later years if the 5-year projections of DOE and OMB are adhered to.

A similar problem has presented itself in the case of the inertial fusion program. This program has had good experimental success in the last few years and is now ready to begin design leading to construction of a "Laboratory Microfusion Facility." Unless real growth in funding is forthcoming, design and near-term R & D for such a facility will restrict our ability to fund those aspects of the inertial fusion program which have long-term civilian payoff. These programs include fusion reactor conceptual design studies and the development of laser and partical beam technologies that are capable of the high efficiency and repetitive pulsing necessary for a commercial power system.

Of immediate concern to this Committee should be the failure of DOE to request funds for the $27 million ILSE heavy ion fusion accelerator at LBL. Heavy ion fusion accelerator development has been a part of DOE's Basic Energy Sciences programs. As a consequence of DOE deciding not to fund the ILSE accelerator, they are also seriously considering abandoning heavy ion fusion accelerator development altogether. I urge this Committee to authorize the ILSE project and to direct the DOE BES office to continue this important program.

Fusion research and development is important to our nation's future. The fusion community appreciates the support it has received from this Committee over the years.

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*Presented to House Committee on Science, Space and Technology, House Committee on Appropriations, Senate Committee on Energy and Natural Resources and Senate Committee on Appropriations during April 1988.

EXECUTIVE NEWSLETTER

JUNE 1988

FUSION POWER ASSOCIATES

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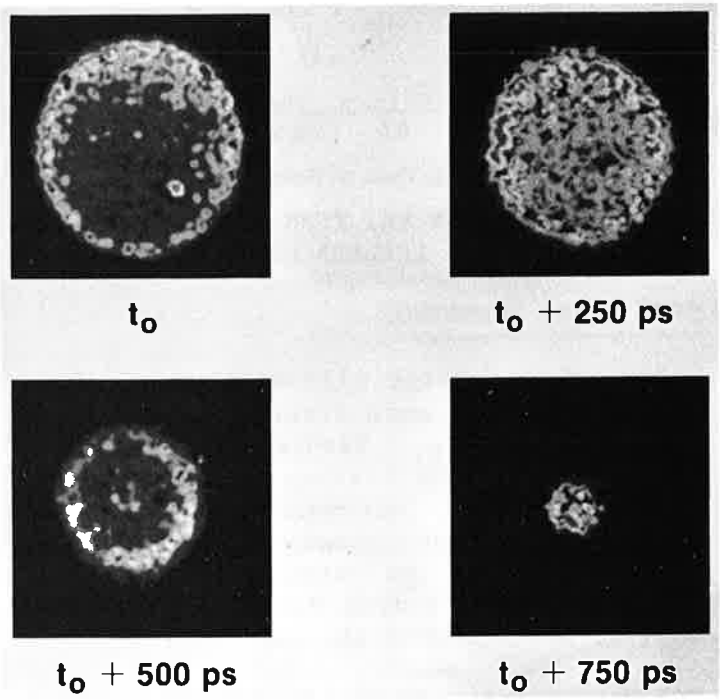
ROCHESTER ACHIEVES EFFICIENT COMPRESSION

Scientists at the University of Rochester Laboratory for Laser Energetics have announced achieving compression of deuterium-tritium capsules to 100-200 times liquid density using less than 2 kilojoules of laser light at 351 nanometers wavelength. Approximately 1000-fold compression will eventually be required to achieve about a hundredfold excess of energy release compared to the energy required to compress and ignite a fusion pellet.

Scientists at the Lawrence Livermore National Laboratory had previously achieved similar compressions (see our October 1984 newsletter) using 4.5 kilojoules of laser light at 530 nanometers wavelength. In the Livermore case, the laser light is first converted to x-rays before uniform irradiation of the target (a process called "indirect drive").

At Rochester, the laser impinges directly on the target ("direct drive"). Direct irradiation of the target is known to be more efficient, but achieving the required degree of uniformity and symmetry is more difficult than with indirect drive. The Rochester results represent a major advance in achieving a high degree of symmetry using the direct drive process. The high degree of uniformity of laser irradiation was achieved by modifying the phase fronts of the 24 original laser beams to effectively produce over 250,000 overlapping beamlets.

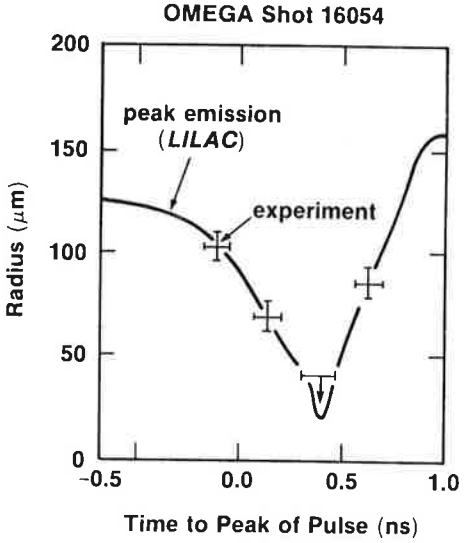
In achieving their results, the Rochester scientists also demonstrated a new diagnostics technique, providing the first direct measurement of the fuel areal density, by measuring the number of deuterium/tritium ions elastically scattered by the 14 MeV fusion neutrons.



X-RAY FRAMING CAMERA PHOTOS OF CAPSULE IMPLOSION

A team of scientists from other inertial fusion laboratories, convened by DOE to review the results, stated that "Using assumptions of fuel mass conservation and a conservative simple model of fuel and fusion production distribution, the committee is confident, based on the data and analysis presented to it, that fuel densities in excess of 100 times liquid density have been achieved. This indicates that significant improvements in drive symmetry and uniformity have been achieved ...."

The committee commented that the total number of fusion reactions in the experiment was lower than expected, due possibly to a mixing effect between the imploding shell and the fuel, but noted that "to achieve these results significant improvements both in laser uniformity on target by the use of distributed phase plates and in cryogenic target technology were made by the UR/LLE staff."



TARGET RADIUS VS. TIME COMPARED TO 1-D CODE (LILAC) PREDICTION

TORE SUPRA OPERATES

TORE SUPRA, a large $133 million superconducting tokamak, made first plasma on April 6 at Cadarache, France. Initially, currents of 1.7MA lasting 30 seconds will be tested but, ultimately, it may be possible to produce steady state conditions in the device. An international team of researchers, including U.S. participation, will be working with the experiment.

DOE MAGNETIC FUSION BULLETIN BOARD

Computer access to a variety of information on the U.S. magnetic fusion program can be obtained through a user-friendly hookup. Call (301) 353-6167 and the computer will tell you how to proceed, no charge. You can also put progress reports or other messages of your own into the system or use the system for electronic mail. If you have problems, call the bulletin board's mastermind: Stan Staten (301) 353-4590.

PEOPLE

Masaji Yoshikawa has been named Director General of the Naka Fusion Research Establishment of the Japan Atomic Energy Research Institute. He succeeds Ken Tomabechi, who will direct the design effort for an International Thermonuclear Engineering Reactor (see our May newsletter).

Richard J. Briggs has been named Acting Associate Director for Magnetic Fusion at the LLNL succeeding Ken Fowler. Briggs also continues to direct the particle beam program.

Frederick J. Mayer has left KMS Fusion where he was Director of Advanced Research, to form his own consulting practice. He can be reached at 1417 Dickens Drive, Ann Arbor, MI, 48103 (313) 663-0627.

FUSION SMALL BUSINESS

Of the 19 Phase I Small Business Innovation Research (SBIR) awards in magnetic fusion research given by the Department of Energy in 1987, 14 have been given Phase II awards. The 14 awards were given to (1) Corum Industries, Inc., Atlanta, for composite materials with low-Z, self-regenerating coatings for first walls and limiters; (2) KMS Fusion Inc., Ann Arbor, Mich., for a tritium permeation resistant polymer coating; (3) Remote Technology Corp., Oak Ridge, Tenn., for an in-vessel manipulator concept for the Compact Ignition Tokamak; (4) Technical Research Associates, Salt Lake City, for graphite-reinforced copper alloys (5) Radiation Science Inc., Belmont, Mass., for development of shielded x-ray plasma diagnostic detectors; (6) Science Research Laboratory, Somerville, Mass., for a novel optical concept for rapid scanning two-dimensional Thompson Scattering, (7) Applied Science and Technology, Newton, Mass., for a microwave ion source for remote leak detection and vacuum analysis instrumentation (8) Batzer and Associates, Livermore, Calif., for gate valves; (9) Composite Technology Development, Boulder, Colo., for radiation-resistant organic insulators for superconducting magnets; (10) Physical Sciences Inc., Alexandria, VA., for a 5 MW, 300 GHz quasi-optical gyrotron; (11) Pyromet Inc., Aston, Pa., for continuous extrusion of Nb_3Sn superconductors; (12) Spire Corp., Bedford, Mass., for advanced insulating coatings; (13) Supercon Inc., Shrewsbury, Mass., for process development for producing Nb_3Sn multifilament superconductors of high current density; and (14) Supercon Inc., Shrewsbury, Mass., for the development of a process for making multifilamentary conductors.

中国北京

清華大學

Tsinghua University, Peking, the People's Republic of China

Li,Xing Zhong
Modern Physics Institute
Department of Physics
Tsinghua University
Beijing
People's Republic of China

Jan.10,1988

Dr. Stephen O. Dean,President
Fusion Power Associates
2 Professional Drive,Suite 248
Gaithersberg, Maryland 20879
USA

Dear Dr. Dean:

I became a member of your Fusion Power Associates when I was at the University of Wisconsin. I appreciate the way in which you operate. I believe that it helps the Fusion community in many aspects. Since I have returned to China, your executive newsletter of Fusion Power Associates becomes one of my important windows to keep me updated with the world fusion business. I always keep my membership when the source of foreign currency is available.

Sorry about the delay this year for the renewal of the membership,because I don't know when and whether I shall get through the procedure in my University for the foreign currency.

The fusion research started in 1959 at my University. It was destroyed in 1960's. My new task is to restore the fusion program in my Alma Mater, starting from a conceptual design of fission-fusion hybrid reactor.

Thank you for the January 1988 Issue of the executive newsletter of the Fusion Power Associates.

Best wishes.

Sincerely yours,

Li, Xing Zhong

Li,Xing Zhong
Associate Professor

AE Labs Inc.
Aneutronic Energy Labs Inc.

University of Florida Research and Educational Center
Welaka, Florida 32093-0366
Telephone: 904-467-3103

14 Washington Rd., Bldg. #6
Princeton Junction, New Jersey 08550
Telephone: 609-275-7337
Telex: 205699 AEL

Bogdan C. Maglich
Chairman and Chief Scientist

April 26, 1988

Dr. Stephen Dean
President
Fusion Power Associates
2 Professional Drive
Suite 248
Gaithersburg, MD 20760

Dear Steve,

Members of Board of Directors and Scientific Advisory Board of AELabs have drawn my attention to the fact that your newsletter never reports the results of our research program and that discriminatory reporting may be in violation of the non-profit status and charter of Fusion Power Associates. Please be informed that the product Tn_cT for migma has reached $4X10^{14}$ KeV $cm^{-3}s$ in 1982 [Technology Review Oct. Nov. 1982 p. ; Phys. Rev. Letters 54, 796 (1985)].

It has also been noted that you are presenting that the USSR as working on the Tokamak program, in parallel with and to the benefit of the United States, while the Soviet Tokamak construction program has been cancelled January 1976 and never reinstated.

Every unfair reporting can cause financial damages to the small R&D companies which are then forced to seek remedies under the law.

With regards,

Sincerely,

Bogdan Maglich

BCM/lp

EXECUTIVE NEWSLETTER

JULY 1988

FUSION POWER ASSOCIATES

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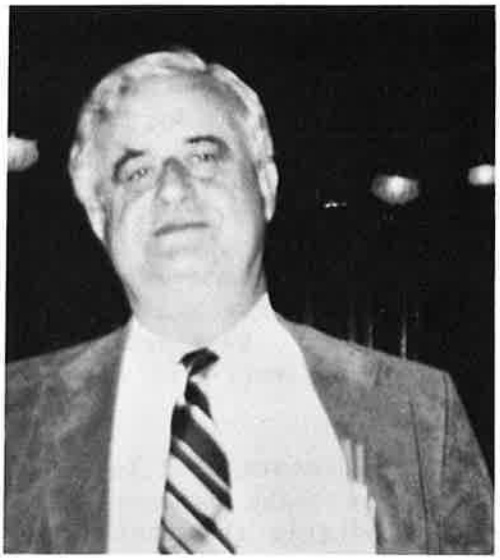
(301) 258-0545

FPA LEADERSHIP AWARD TO ROSENBLUTH

Marshall N. Rosenbluth, University of California at San Diego and General Atomics, has been presented Fusion Power Associates' Leadership Award for 1987. The awards, which were initiated in 1980, are presented annually by the FPA Board of Directors to those individuals who have shown outstanding leadership qualities in accelerating the development of fusion. The award was presented to Rosenbluth at a dinner in his honor June 15 in San Diego by FPA board member and co-founder Nick Krall. The award cites Rosenbluth for his "countless contributions to the science of plasmas" and states "you have regularly provided advice to both the magnetic and inertial fusion programs, thereby guiding those programs toward the development of a working fusion system."

FPA board chairman Harold Forsen, who was unable to attend the ceremony, sent a letter to Rosenbluth stating "Your contributions to the understanding of plasma physics and the several embodiments of containment systems have enabled much of the progress we enjoy today. Your leadership as a teacher, adviser and statesman has further added to the progress of controlled fusion through the action of others. For these and many other technical and humane efforts, we thank you. The Leadership Award through its name speaks for itself, and I can think of no one more richly deserving. Congratulations again, and may this award add some small amount of pleasure to the realization you must already have, that you have had a major impact on history."

A letter from Office of Fusion Energy director John Clarke was also presented to Rosenbluth at the dinner.



MARSHALL N. ROSENBLUTH

Department of Energy
Washington, DC 20545

June 9, 1988

Dr. Stephen O. Dean
Director
Fusion Power Associates
2 Professional Drive, Suite 248
Gaithersburg, Maryland 20879

Dear Steve,

I commend Fusion Power Associates for honoring Marshall Rosenbluth and recognizing the tremendous leadership that he continues to provide in fusion research. While Marshall's impressive achievements are often cited, his leadership is an equally effective factor in advancing fusion worldwide.

Leadership requires ample amounts of several attributes that are rarely found together in one person. First, a leader should have the credentials of achievement to establish his position. Second, a leader must make a strong, personal commitment to excellence and dedicate himself to the attainment of excellence to provide an example to others. Third, there must be a willingness to accept the responsibilities of leadership, such as the courage to act, to challenge, and to change. Fourth, a leader needs to have an unquenchable, contagious conviction in his soul that can stimulate others to pursue a worthwhile goal. Finally, a leader must have the respect of those he is leading. Marshall Rosenbluth certainly has all these attributes in abundance.

Throughout his professional career, Marshall has left his mark on both the institutions where he worked and his colleagues. Those of us who have had the opportunity to work with Marshall are grateful for his vision, conviction, and conscientious pursuit of the scientific understanding that will someday make fusion power a reality.

Sincerely,

John F. Clarke
Associate Director for
Fusion Energy
Office of Energy Research

FUSION CANADA

On March 29, 1988 a joint venture agreement was signed, completing all formalities for funding and administration of the Canadian Centre for Magnetic Fusion. The Centre operates the Tokamak de Varennes as a joint venture between Hydro-Quebec, Atomic Energy of Canada Ltd. (AECL) and Institut national de recherche scientifique (INRS-Energie). AECL signed the agreement in its capacity as the federal agency responsible for operating the National Fusion Program. Annual budget for the Centre is at present near $10 million per year, planned to increase to near $15 million per year by 1992.

In addition to continuing its engineering-oriented magnetic fusion research, the Centre will increasingly act as a focal point for expanding industrial participation and experience in fusion, in Quebec and throughout Canada. Development of fusion scientists and engineers is another important goal.

The Board of Directors will include members representing the three partners, as well as members from outside the fusion community. There is also an Advisory Committee made up of Canadian and foreign magnetic fusion experts.

Manager of the Centre is Dr. Richard Bolton, who directed the tokamak's construction phase.

An illustrated 32 page book entitled "Fusion: What Canada Can Do" is available as a guide to capabilities in Canada's fusion establishments. The book encompasses industry, universities, and research laboratories. Each organization describes its role and special areas of interest; corporations describe their fusion-related goods and services. The introduction outlines the roles and functions of the three key fusion centres; the National Fusion Program, the Canadian Centre for Magnetic Fusion and the Canadian Fusion Fuels Technology Project. The book is available free on request from James Weller, Vice President, Canadian Nuclear Association, 111 Elizabeth St., Toronto, Ontario, Canada, M5G 1P7, (416) 977-6152.

Persons who wish to receive the newsletter "Fusion Canada" should contact MacPhee Offices, Suite 300, 988 Yonge St., Toronto, Ontario, Canada, M4W 2J5 (416) 925-3117. Persons wishing to receive the Ontario Hydro newsletter "Fusion Fuels Technology" should contact Janine Niewswandt, CFFTP, 2700 Lakeshore Road West, Mississauga, Ontario, Canada, L5J 1K3, (416) 823-0200.

ITER CORRECTIONS

Contrary to our May newsletter, the following persons/committees are directing the ITER effort. The ITER Management Committee (IMC) is responsible for executing the conceptual design activities. The IMC members are K. Tomabechi (Japan, Chairman), R. Toschi (Euratom), J. Gilleland (USA), Yu. A. Sokolov (USSR). This committee reports to the 8-member ITER Council (IC). The IC members are J. Clarke (USA, Chairman), J. Decker (USA), E. Velikhov and N. Cheverev (USSR), K. Ida and S. Mori (Japan). P. Fasella and C. Maisonnier (Euratom). Independent technical advice will be provided to the IC, at its request, by a 12-member ITER Scientific and Technical Advisory Committee (ISTAC). The ISTAC members are B. Kadomtsev (USSR, Chairman), Chuyanov and Krylon (USSR), Fowler, Rutherford and Conn (US), Sekiguchi, Inoue and Tanaka (USSR), Troyan, Rebut and Sweetman (Euratom).

A 72-page booklet entitled "ITER," containing the relevant documents establishing the ITER effort, is available from the DOE Office of Fusion Energy, (301) 353-3347 or from Manfred Leiser, IAEA, P.O. Box 100, A-1400, Vienna, Austria.

ANS NUCLEAR ENGINEERING SOURCEBOOK

The ANS Education and Training Division has published a Sourcebook giving the names addresses and specialities of institutions and faculty members involved in nuclear engineering education and training, as well as contacts for local ANS student chapters. Copies can be obtained from John G. Gilligan, North Carolina State University, Dept. of Nuclear Engineering, Box 7909, Raleigh, NC, 27695-7909, (919) 737-2301.

FUSION APPLICATIONS IN SPACE

A special minicourse on Fusion Applications in Space will be given in Salt Lake City, on Sunday, October 9, 1988, preceeding the 8th ANS Topical Conference on the Technology of Fusion Energy. George Miley, University of Illinois, will coordinate the course. The course fee is $150. Contact Ms. Chris Stalker, (217) 333-3772.

PEOPLE

David Ehst has been promoted to senior nuclear engineer in the Applied Physics Division at the U.S. Department of Energy's Argonne National Laboratory. He joined Argonne's staff as an assistant nuclear engineer in 1976.

A member of the American Physical Society, Division of Plasma Physics, Ehst has written 130 publications, including 11 journal articles and contributions to six books.

DAVID EHST

Donald Dudziak has been named a Los Alamos National Laboratory Fellow. He joins a select group of about 60 at the Lab who have been so-recognized.

Don is an internationally recognized expert in radiation shielding, reactor physics and fusion reactor technology. Don joined Los Alamos in 1965. He has been in a variety of research and management positions, including leader of the Transport and Reactor Theory Group from 1978 to 1982. He is currently deputy leader of the Systems Analysis Group and section leader for high-technology systems studies. His additional scientific interests include inertial confinement fusion, sensitivity and uncertainty analysis, probabilistic processes and accelerator neutron sources.

Gene McCall of Los Alamos National Laboratory, has been chosen by DOE to receive one of its prestigious E.O. Lawrence Awards for outstanding contributions related to atomic energy. Along with a citation the award includes a medal and a $10,000 prize. McCall is cited for his pioneering work in the field of laser-driven inertial fusion and its application to nuclear weapon design and diagnostics; for his early, independent work on laser-plasma interactions and the role of electron heating; and for his work on hypervelocity particles and shockless acceleration to enable development of a new class of directed energy weapons.

Allen Mense has left his post as acting chief scientist of the Strategic Defense Initiative Office to become vice president for research at the Florida Institute of Technology, 150 West University Blvd., Melbourne, FL, 32901-6988 (407) 768-8000, ext. 8043.

Nermin Uckan has been elected vice chairman/chair-elect of the ANS Fusion Energy Division. Nermin has also joined the ITER design group in Garching. Don Dudziak and Steve Piet have been elected to the executive committee of the ANS Fusion Energy Division. Ralph Moir has been elected secretary-treasurer.

Richard Briggs has been named Associate Director of LLNL for Beam Research and Magnetic Fusion Energy. In one of his first actions, Briggs designated B. Grant Logan to be Deputy Associate Director for MFE Development and Plans; Keith Thomassen to be Deputy Associate Director for MFE Experiments, and Lois Barber to be Administrative Staff Supervisor for both M-Division and F-Division. He also named Donald Prosnitz to be Acting Deputy Associate Director for Beam Research. Bill Lakke continues to serve as department head for both programs.

ORNL AWARDS

Each year Martin Marietta Energy Systems holds an awards banquet at which the leading accomplishments of the 18,000-person organization are recognized. The top honors go to five people who are named the Manager, Engineer, Scientist, Inventor, and Author of the Year. This year two of the five honors were won by members of ORNL's Fusion Program.

Paul Haubenreich was named Manager of the Year for his leadership of the Large Coil Program. The Large Coil Program, which was completed this year, was not only a technical success but also an outstanding example of international cooperation. Haubenreich, who managed the Program over its 12-year life, is leaving for the IAEA Headquarters in Vienna where he will serve as the Secretary of the International Thermonuclear Experimental Reactor (ITER) Council.

Ray Johnson was named Engineer of the Year for his lead role in the design and construction of the Advanced Toroidal Facility, ORNL's new stellarator. The complex shape, tight dimensional specifications, and design for steady operation made the ATF a particularly challenging engineering task. Under Johnson's leadership, it was completed successfully and within budget and is now beginning experimenal operation.

EXECUTIVE NEWSLETTER

JULY 1988
SPECIAL EDITION

FUSION POWER ASSOCIATES

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(301) 258-0545

BUDGET UPDATE

House-Senate Conferees agreed to provide $351.5 million for magnetic fusion research for the fiscal year beginning October 1, 1988. This represents an increase of $16.5 million over the current budget of $335 million but was $8.5 million less than the president's FY 1989 request. The $8.5 million was removed from the requested amount of $12 million for CIT (Compact Ignition Tokamak) construction funds, leaving $3.5 million in that category to be added to the $8 million available this year. The construction funds have been restricted by Congress to use for Title I engineering design only. In addition to the construction funds, approximately $7.5 million in FY 1988 and $15 million in FY 1989 will be spent on CIT out of operating funds.

Conferees also agreed to provide $163.7 million for inertial confinement fusion, an amount equal to the president's request. This represents an increase of $4.7 million over the FY 1988 appropriation of $159. Of the $163.7 million, $12.9M was earmarked for the University of Rochester and $16.8M for KMS Fusion, including $0.7M for capital equipment at KMS.

In approving the request, the committee called for an independent review of inertial confinement fusion to update the review by the National Academy of Sciences, completed two years ago (see our June 1986 newsletter). The conference report stated that "as part of the review, an assessment of the civilian energy potential of inertial fusion should be included." Civilian application assessment was excluded from the previous academy review.

ANS FELLOW CHARLES C. BAKER

BAKER NAMED ANS FELLOW

The American Nuclear Society has conferred the rank of FELLOW on Dr. Charles C. Baker, director of the Fusion Power Program at Argonne National Laboratory. In the citation, the ANS Board of Directors praises Baker for his "leadership of the STARFIRE fusion reactor design study, the Department of Energy's national 'Technical Program Analysis' activity, and the fusion nuclear engineering blanket concept comparison study; also for his service to the American Nuclear Society and for his leadership in the fusion field."

FUSION AT THE SUMMIT

At the conclusion of the recent Reagan-Gorbachev Summit Meeting in Moscow, the following appears in the Joint Statement issued by the two leaders:

"The President and the General Secretary noted with pleasure the commencement of work on a Conceptual Design of an International Thermonuclear Experimental Reactor (ITER), under the auspices of the IAEA, between scientists and experts from the U.S., USSR, European Atomic Energy Community, and Japan. The two leaders noted the significance of this next step toward the development of fusion power as a cheap, environmentally sound and essentially inexhaustible energy source for the benefit of all mankind."

FUSION ENVIRONMENT, SAFETY AND ECONOMICS

The Magnetic Fusion Advisory Committee has accepted the report of a panel chaired by Peter Staudhammer of TRW and sent a letter to James Decker of DOE stating that "fusion has the clear potential of a safe and environmentally acceptable energy source" and that "based on the projection of the cost of electricity, fusion reactors have the potential to be generally competitive with other energy options." Further, MFAC states that "because of the leverage provided by environment and safety considerations, it is important to raise the level of consciousness of these factors in all elements of the fusion program and program planning." They urged that "continued work should be encouraged on advanced technology and advanced reactor concepts, which take advantage of the unique characteristics of fusion and which may result in environmental, safety, and economic advantage." Copies of the letter may be obtained from Fusion Power Associates.

FUSION REACTOR-RELEVANT TECHNOLOGY (RRT)

The Magnetic Fusion Advisory Committee has also accepted a report of a panel chaired by Charles Baker of ANL and sent a letter to James Decker of DOE stating that "systems studies and conceptual reactor design studies provide a 'vision of the future' that is sufficient to define the breadth, scope and timing of the RRT program," noting that "plasma technology and systems studies are essential parts of RRT," in addition to programs in fusion nuclear technology and materials. MFAC states that "since it is not possible for any one country to carry out by itself the full required RRT program, international collaboration is essential." They further stated that the development of a high fluence/high flux 14 MeV neutron source "is a promising candidate for international collaboration." They state that "the principal benefit from the RRT program over the next ten years is the support it provides to the technology development for ITER and its test program. Other near-term impacts are increased confidence that advanced materials are feasible, increased confidence in achieving steady-state operating conditions, and narrowed choices for fusion reactor blankets." Finally, MFAC states that "the U.S. effort on long-lead elements of RRT is inadequate and has become subcritical. An important need is for new test facilities, perhaps in cooperation with other countries." They called for budget increases of $10-15 million over the current budget as necessary to "restore the program to a critical size." Copies of the letter are available from Fusion Power Associates.

GRUMMAN WINS NEUTRAL BEAM CONTRACT

Los Alamos National Laboratory and Grumman Corp. have signed a three-year $15 million contract to jointly develop at Los Alamos a neutral particle beam accelerator. "The signing of this contract marks the beginning of a new era in laboratory-industry cooperation," said Richard Burick, Los Alamos' neutral particle beam program director.

Grumman personnel will be fully integrated into the Los Alamos accelerator program, participating in all phases of the project. "This will allow for transfer of neutral particle beam technology to private industry," said Burick.

Grumman Corp., headquartered in Bethpage, NY, will have 22 people stationed at Los Alamos. Twelve of those are already working at Los Alamos. Another 22 Grumman scientists, engineers and technicians will work on the accelerator project, but remain at the Long Island corporate headquarters.

EXECUTIVE NEWSLETTER

AUGUST 1988

FUSION POWER ASSOCIATES

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BOB HUNTER TO HEAD DOE ENERGY RESEARCH

The Senate recently held hearings on the nomination of Dr. Robert Hunter to become DOE Director of Energy Research. His confirmation appears certain. He will replace Dr. Alvin W. Trivelpiece who left the post in the spring of 1987 to become Executive Director of the AAAS. Dr. James Decker has been filling the post on an acting basis since that time. Hunter is a plasma physicist who received his Ph.D. from the University of California at Irvine. He worked at both the Air Force Weapons Laboratory and Maxwell Laboratories before forming his own company, Western Research Corp. Western Research has been acquired by Thermo Electron Corp., Waltham, MA.

ART SLEEPER STARTS CANCER RESEARCH

Fusion scientist Arthur Sleeper (formerly with the DOE Office of Fusion Energy and General Atomics) has completed his residency at Johns Hopkins Hospital in Baltimore, MD, after receiving his M.D. from the University of Miami. He recently visited with his former colleagues telling us that he was now working with "the Bruno Coppi of cancer research." We congratulate Arthur on his many accomplishments and thank him for his past contributions to fusion research. He can be reached at 2015 Pheasant Cross #201, Baltimore, MD, 21209 (301) 235-3221.

US-USSR CIT COLLABORATION

Tom James of DOE and Tip Brolin of Princeton led a team of 7 persons from the U.S. fusion program to the Soviet Union June 12-18 to discuss potential collaboration on the Compact Ignition Tokamak (CIT). The group met with a team of 50 Soviet counterparts including V. A. Chuyanov, head of the T-14 tokamak. Milt Machalek, a member of the U.S. team described the visit as "very productive." The U.S. team toured a Soviet plant where motor generators are manufactured. The possibility of the Soviets providing 7 GJ from several flywheel generators is the cornerstone of the discussions, which also include the possibility of Soviet supply of diagnostics and/or the possibility of permitting U.S. firms to manufacture Soviet gyrotrons under license. The generators alone could save the U.S. program $30-35 million in CIT costs. In return, the Soviets would send 5-15 people to Princeton to participate in CIT when the project becomes operational. A formal plan to collaborate will now be reviewed, and hopefully endorsed, at the early October meeting of the joint U.S.-USSR Fusion Power Coordinating Committee and eventually it will have to be approved by higher level bodies in both governments.

ARTHUR SLEEPER CHATS WITH DOE'S N. ANNE DAVIES

DENSE PLASMAS

The Second International Conference on High-Density Plasmas will be held April 26-28, 1989 in Laguna Beach, CA. Conference topics include gas jets, wires and foils, fiber pinches, plasma focus and vacuum sparks. U.S. sponsors include the U.S. Naval Research Laboratory, Maxwell Laboratories, Sandia National Laboratories, Physics International and Berkeley Research Associates. Persons wishing to present papers should contact Nino R. Pereira, Berkeley Research Associates (703) 750-3434.

A group of U.S. and Soviet scientists met in Santa Fe the week of May 24 for a workshop on "Nonlinear Processes in Dense Plasmas," under an agreement between the Academies of Science of the two countries. Richard Morse of Los Alamos was coordinator for the workshop. According to Don DuBois of Los Alamos, "a common theme of much of the research (discussed) was the fundamental work in nonlinear research done by Professor Vladimir Zakharov of Moscow's Landau Institute. Another main topic was the interaction of particle and radiation beams with plasmas. While in the area the Soviets toured the Aurora inertial fusion site.

PEOPLE

John Emmett has been named to the new post of associate director for Program Development at the Lawrence Livermore National Laboratory. Emmett was previously associate director for Lasers, responsible for the inertial fusion and laser isotope separation programs. In his new post he will be responsible for the development of new programs and assist laboratory director John Nuckolls in the management of the laboratory. Emmett was a recipient of Fusion Power Associates leadership award in 1983.

Joe File has been named Technology Transfer Officer at the Princeton Plasma Physics Laboratory (PPPL). He will devote full time to ensuring that useful technical developments at PPPL are made available to private industry and the state and local governments. He can be reached on (609) 243-3009.

100 YEARS FROM NOW

"August 5, 2088, MARS--Twelve college students born and raised on Mars left for Earth today for a special three-year program with a group of colleges on Earth. The students, all juniors at Mars University, elected to study abroad and to participate in a lecture program across the United States. The aim of the program is to familiarize Earth-residents with the Mars colony and to recruit young colonists for Mars."

The above is reprinted from the new bimonthly magazine 21st Century Science and Technology. For a sample issue and subscription information ($20/year) contact 21st Century, P.O. Box 65473, Washington, D. C. 20035.

MEETINGS

August 21-25 Applied Superconductivity Conference. Sheraton Palace Hotel, San Francisco. Contact Dr. Carl Henning, L-644, LLNL, Livermore, CA, 94550 (415) 422-0235.

Sept. 6-8 Fusion Power Associates Annual Meeting and Symposium on "The Creation of Compact, High Power Density Plasmas," Santa Fe. Contact Ruth Watkins (301) 258-0545.

Sept. 7-8 Magnetic Fusion Advisory Committee Public Meeting, Los Alamos. Contact Fred Ribe (206) 543-0355.

Sept. 19-23 APS Topical Conference on Plasma Astrophysics. Santa Fe. Contact Sheron Trujillo (505) 667-8366.

October 2-7 35th National Vacuum Symposium. Atlanta. Contact AVS (212) 666-9404.

October 3-7 Tritium Safe Handling Course. Toronto. Contact (416) 823-0102.

October 9-13 Eighth (ANS) Topical Meeting on the Technology of Fusion Energy. Salt Lake City. Contact J. G. Crocker (208) 526-9929.

October 12-19 12th IAEA International Conference on Plasma Physics and Controlled Nuclear Fusion Research. Nice, France. Contact Dave Crandall (301) 353-4996.

EXECUTIVE NEWSLETTER

SEPTEMBER 1988

FUSION POWER ASSOCIATES

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SUSAN KINKEAD JOINS FPA

Ms. Susan D. Kinkead has joined Fusion Power Associates as Director of Public Affairs. She was previously vice president, 21st Century Energy, Monterey, CA. Susan will be responsible for FPA's relations with our member corporations, the media and congressional staff. In addition, she will assist FPA president Steve Dean as a research assistant on several technical studies in progress. Susan has a BA from the University of California (Davis) and a MA from the Monterey Institute of International Studies. She also worked as a scientific/technical translator in Paris, France, 1984-1986 and served as a French interpretor/translator during the visit of Pope John Paul to Monterey in 1987 and during the Los Angeles Olympic games in 1984. We welcome Susan to the FPA office.

SUSAN D. KINKEAD, FPA DIRECTOR OF PUBLIC AFFAIRS

SENATORS FILE NEW ENERGY POLICY BILL

Eighteen senators led by Sen. Tim Wirth (D-CO) have introduced a bill (S.2667) "to establish a national energy policy to reduce global warming, and for other purposes." Some of the other senators co-sponsoring the bill include Messrs. Johnston (D-LA), Pell (D-RI), Gore (D-TN), Danforth (R-MO), Bingaman (D-NM), and Evans (R-WA). The bill outlines a comprehensive strategy to move the country away from fossil fuel burning.

Included in the bill is a section on fusion requiring the Secretary of Energy to provide within one year a plan showing how fusion research and development could be brought to fruition by the year 2010. At that time, the bill says, the fusion program should have in place "a design of a prototype commercial fusion reactor, accompanied by cost estimates and specifications sufficient to permit bids for construction of the reactor."

We urge all of our readers to write to their senators in support of this bill. Please tell them that they may obtain additional information from FPA. Hearings on the bill are not expected until next spring.

PARTY PLATFORMS

The Republican Platform states that the party "supports funding for research and development, particularly where current market economics preclude private initiatives." The platform states "We will also support research and development for energy efficiency, conservation, renewables, fusion and superconductivity." The Democratic Platform makes no mention of fusion.

DUKAKIS AIDE KNOCKS FUSION

Dukakis issues director Christopher Edley, Jr., in a widely circulated interview in the July 29 Washington Post, stated that Dukakis "would eliminate immediately, if elected,

research on a high-speed hyperspace aircraft, research on nuclear fusion and money-losing timber sales from the national forests."

In response to numerous inquiries from fusion supporters, Dukakis campaign aides responded that Edley was misquoted; that no decisions had been made on eliminating specific programs. They explained that someone in the campaign office had suggested that the fusion program be reviewed to determine whether its budget was too large compared to so-called "renewable" energy programs. Gillion Gansler, press secretary for the Massachusetts State Energy Office, stated that as governor, Dukakis has taken no specific stand on fusion power.

HEAVY ION FUSION SYMPOSIUM

The 1988 International Symposium on Heavy Ion Inertial Fusion was held June 28-30 in Darmstadt FRG. Over 130 persons from 12 countries participated. Progress was noted in developing high-current accelerators for both rf and induction linacs. Also, the German and French programs have moved into an experimental phase in topics such as energy deposition of heavy ions in hot, dense matter. For a written summary of the symposium, contact Terry F. Godlove (202) 767-0610.

CENTER, MONSLER ELECTED TO FPA BOARD

Bob Center, president of Spectra Technology and Mike Monsler, general manager, San Francisco operations for W. J. Schafer Associates, have been elected to three-year terms on Fusion Power Associates Board of Directors beginning November 1, 1988. We welcome them to our Board. Also re-elected to additional three year terms were: Christian C. Bolta (Combustion Engineering), Robert Botwin (Grumman Aerospace Corp.), Don Dautovich (Ontario Hydro), John Davis (McDonnell Douglas Astronautics Co.), Steve Dean (Fusion Power Associates), Harold Forsen (Bechtel) and Robert C. Iotti (Ebasco Services). Also, Timothy M. Henderson, vice president of technical programs, KMS Fusion Inc. has been elected to FPA's Board of Directors, replacing Board member Terry Liddy of KMS. His term expires October 31, 1990. We welcome Tim to our Board.

FUSION SPINOFFS IN JAPAN

A Committee on Spin-Off Effects of Nuclear Fusion R&D, headed by Kenzo Yamamoto, Nagoya University professor emeritus and senior advisor to the Japan Atomic Industrial Forum, has compiled an analysis of the near-term commercial spinoffs of current fusion research. They have concluded that nuclear fusion has resulted in 41 spinoffs to other fields, of which 18 are judged to have had "an especially great spinoff effect." They also concluded that an additional 42 spinoffs were accomplished jointly by fusion and other fields. Seven typical "cases in point" cited in the study are (1) a ceramic turbomolecular pump, (2) a large capacity ion source which led to an ion beam milling system, (3) tetrodes and klystrons which led to improvements in the broadcasting industry, (4) a dc circuit breaker which is being used in dc transmission systems, (5) supercomputer developments (6) high manganese non-magnetic steels being used in the development of magnetically-levitated high speed trains and (7) electron beam welding equipment.

For further information, contact Mr. Nobuyuki Morino, Manager, Nuclear Fusion Project, Hitachi Ltd., 6, Kanda-Surugadai 4-chome, Chiyoda-ku, Tokyo 101, Japan.

PAPERS OF INTEREST

FPA president Steve Dean presented a paper entitled "Impact of High Temperature Superconductors on the Possibility of RF Confinement" at the Applied Superconductivity Conference on August 22. Copies are available from Fusion Power Associates.

Dean has also been asked to give an invited paper at the 8th Topical Meeting on the Technology of Fusion Energy in Salt Lake City, October 10. The paper, entitled "Status of Candidate Drivers for a Laboratory Microfusion Facility," is coauthored by Alex Glass, Frank Feiock, Terry Godlove and Alan Toepfer. It is based on a study the five authors performed for the DOE Division of Inertial Fusion in the January-April timeframe. Copies are available from Fusion Power Associates.

EXECUTIVE NEWSLETTER

OCTOBER 1988

FUSION POWER ASSOCIATES

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FPA SMALL BUSINESS AFFILIATES

Small businesses interested in fusion are becoming increasingly successful in their bids to obtain funding through DOE's Small Business Innovation Research (SBIR) program. In recognition of the important contribution that small business can make to fusion development, the FPA Board of Directors has established a category of participation called Small Business Affiliates. Three firms have already applied and have been approved by the FPA Board. The are:

Krall Associates, 1070 America Way, Del Mar, CA, 92014. Dr. Nicholas A. Krall will represent the company. He can be reached at (619) 273-3481.

Lodestar Research Corporation, 2400 Central Ave., Boulder, CO, 80301. Dr. Richard E. Aamodt will represent the company. He can be reached at (303) 449-9691.

Sclufer Associates, 725 Dodds Lane, Gladwyne, PA, 19035. Nicholas Sclufer will represent the company. He can be reached at (215) 549-3980 or (215) 356-6600.

We welcome our first Small Business Affiliates. Other interested companies can contact FPA for information.

MORGAN, SHEFFIELD PROMOTED AT ORNL

O. B. (Bill) Morgan has been named Associate Director for Support and Services of Oak Ridge National Laboratory. Bill has been director of the Fusion Energy Division.

John Sheffield has been named director of the Fusion Energy Division, succeeding Morgan. John has been associate director of the Fusion Energy Division since 1981. We wish Bill and John success in their new positions.

JOHN SHEFFIELD AND BILL MORGAN OF ORNL

MFAC SUMMER STUDY SENT TO DOE

Twelve members of the Magnetic Fusion Advisory Committee were joined by thirty members of the fusion community and eight persons from DOE for a "Summer Study" during the first week of August. They transmitted the results of the study to DOE director of energy research Robert O. Hunter following the MFAC meeting in Los Alamos September 7-8.

In his covering letter to Hunter dated September 8, MFAC chairman Fred Ribe of the University of Washington stated that there were "compelling reasons for a renewed thrust in the quest for fusion development." Ribe said, "The need and timing for this initiative derive from concerns about the undesirable side effects of fossil fuels." His letter states that "At present, the U.S. base (fusion) scientific and technology programs are operating at budget levels too low to permit them to support effectively the CIT and ITER programs and to exploit new ideas enhancing the commercial acceptability of fusion." "The MFAC, as did the Summer

Study Panel, strongly supports (the CIT) initiative within a balanced US fusion program," Ribe said. Copies of the letter are available from Fusion Power Associates.

OHKAWA DISSENTS

By letter dated September 15, MFAC chairman Fred Ribe transmitted to DOE's Robert Hunter a September 12 letter from MFAC member Tihiro Ohkawa of General Atomics, reflecting Ohkawa's formal dissent from the MFAC Summer Study findings. In his letter Ohkawa urged a change in program emphasis "to come up with fusion test reactors of affordable cost and benign environmental characteristics." In such a program, Ohkawa states, "the first priority should be to complete the scientific phase to the extent that the test reactors become affordable. More specifically, the energy confinement must be improved since it is the high-leverage issue constraining the test reactor design." Ohkawa also urged that "Priority in the development and technology area should be on the enhancement of social acceptability." Finally, Ohkawa states "The major initiative in the 1990's should then be the initiation and construction of a U.S. fusion test reactor. As the U.S. program regains world leadership in the test reactor phase, the necessity of ITER will diminish. A more fruitful and productive international cooperation should replace it."

Ohkawa was a participant in the Summer Study. Other members of MFAC felt that Ohkawa's concerns were appropriately treated in the Study report. Copies of Ohkawa's letter are available from Fusion Power Associates.

SUMMER STUDY OVERVIEW

The following material has been condensed from the overview section of the Summer Study report.

"The development of fusion energy requires (1) adequate understanding of the underlying plasma science; (2) development of the necessary technologies; (3) integration of the fusion science and technology into appropriate test facilities which demonstrate the required systems performance.

"Systematic progress has been made in all three areas. However, additional improvements are required before sufficient information will be available to allow a definite assessment of the potential of fusion, and there are still many possible development paths from today's status to an ultimate commercial fusion energy source.

"The purpose of the fusion initiative described in this report is to ensure vigorous US participation in the world effort to develop a safe, environmentally acceptable and econmic energy source. The proposed fusion initiative, (illustrated in the figure), consists of three important program thrusts and seven specific action initiatives. The three program thrusts are:

"(1) the US program to construct a compact ignition tokamak (CIT); (2) the international design of an International Thermonuclear Experimental Reactor (ITER); (3) R&D programs to ensure realization of the environmental, safety, and economic potential of fusion as a commercial energy source.

"The first action initiative shown (in the figure) is to provide for the timely construction of CIT. Although CIT has long been recognized as a central thrust of the US program, funds have not yet been authorized to complete the construction on a timely basis. The DOE charge setting up the present MFAC panel implies that CIT is an already approved project. However the panel participants noted that construction funds for hardware procurement have not yet been authorized by Congress. In addition, the DOE five year "flat budget" plan results in an undesirably long construction schedule for CIT. Consequently members of the summer study pointed out that additional funds are needed, over and above the current DOE budget, to expedite the construction of CIT. Expediting CIT construction not only will result in obtaining important information on ignition physics at an earlier date but also will ensure that the U.S. will be ready to focus its attention on ITER construction on a timely basis.

"The second action initiative shown (in the figure) is to improve predictive capability for tokamak confinement. Facilities like CIT and ITER might be made smaller and less expensive if we could extrapolate plasma transport with higher confidence from present experiments. In addition, better understanding of the basic principles

PURPOSE	VIGOROUS US PARTICIPATION IN THE WORLD EFFORT TO DEVELOP A SAFE, ENVIRONMENTALLY ACCEPTABLE, ECONOMIC ENERGY SOURCE		
PROGRAM THRUSTS	SUPPORT CIT	OPTIMIZE ITER	IMPROVE END PRODUCT
ACTION INITIATIVES	Provide for timely construction of CIT		
	Improve predictive capability for Tokamak confinement		
	Optimize first-stability Tokamaks. Include all necessary science, technology and systems-analysis tasks		
		Develop attractive fusion reactors, including second-stability and alternate concepts. Include all necessary science, technology and systems-analysis tasks.	
	Develop advanced heating technologies for CIT and ITER		
		Develop and test high performance nuclear components with attractive-environ-features, including low activation materials development-and 14-Mev neutron source definition.	
		Design and build Tokamak for integration of steady state physics and technology.	
SUPPORTING ACTIVITIES	A series of medium scale experiments and enhanced use of existing facilities will be required.		
	Effective use of international collaboration and of US industry, university, laboratory and government resources should be sought.		

PROPOSED FUSION INITIATIVE

contributing to transport may lead to development of means for reducing transport, resulting in yet smaller devices. The primary recommendation here is the immediate establishment of a National Confinement and Transport Task Force. The specific ojective of this task force would be to mount a coordinated effort to characterize and understand the processes of cross field transport in tokamaks, with a view to identifying ways to reduce heat transport and improve overall energy confinement. This action initiative should include the development and application of special purpose diagnostics to existing experiments, new, small scale experiments when appropriate, and theoretical support to these efforts.

"The third action initiative shown (in the figure) is to optimize first stability tokamaks, including all necessary science, technology and systems analysis tasks. It is aimed at development of more complete understanding of tokamak physics in the "first stability" regime in which these devices presently operate.

"The fourth initiative shown is to develop attractive fusion reactors, including second-stability and alternate concepts, and all necessary science, technology and systems analysis tasks. This initiative could result in greater improvements for an end product and possibly for ITER. The fusion program requires a coordinated science, technology and systems-analysis attack on what is required for fusion to be commercially attractive. Concepts must be analyzed through design studies; the physics of high power density must be proven and efficient, reliable technology developed.

"The fifth initiative presented is to develop advanced plasma heating technologies, both for CIT and ITER. This initiative specifically relates to electron cyclotron heating and negative ion beam technologies.

"The sixth action initiative shown is a major technology initiative which would improve ITER and also demonstrate features of an improved fusion reactor. This initiative is to develop and test high performance nuclear components with attractive environmental features, including low activation materials development and 14-MeV neutron source definition.

"A seventh initiative is to design and build a tokamak for integration of steady-state (as opposed to pulsed) physics and technology. This is important both to ITER and the fusion end product.

"As part of the above seven action initiatives, support activities will be required, including a series of medium scale experiments and enhanced use of existing facilities. Finally, it is important that effective use of international collaboration and of US industry, university, laboratory and government resources be sought as part of the implementation of all the action initiatives."

Copies of the complete Summer Study Report are available from Fred Ribe, Dept. of Nuclear Engineering, 356 Benson Hall, MS BF-20, University of Washington, Seattle, WA, 98195, (206) 543-0355.

FUSION ENGINEER WINS UCLA GRADUATE WOMAN OF THE YEAR AWARD

Kathryn McCarthy, a graduate student at UCLA, won the UCLA Graduate Woman of the Year Award for her work on fusion engineering. Kathy, whose advisor is Prof. Mohamed Abdou, is expected to finish her Ph.D. this Fall. Her Ph.D. thesis topic is "Analysis of Liquid Metal MHD Flow Using a Core Flow Approximation with Applications to Calculating the Pressure Drop in a Fusion Reactor Blanket." Kathy hopes to work in several countries to help foster international cooperation on fusion.

REPORTS AVAILABLE

A report entitled "Heavy Ion Fusion Accelerator Research 1987" (LBL-25053, April 1988) is available from Denis Keefe, Accelerator and Fusion Research Division, LBL, Berkeley, CA, 94720, (415) 486-6376.

The Canadian Fusion Fuels Technology Project (CFFTP) 1987/88 Annual Report is available from Don Dautovich, CFFTP, 2700 Lakeshore Road West, Mississauga, Ontario, Canada, L5J 1K3, (416) 823-0200.

MEETINGS

Oct. 31-Nov. 1 Annual Meeting of the APS Division of Plasma Physics, Hollywood, Florida. Contact Barbara Sarfaty (609) 243-2440.

EXECUTIVE NEWSLETTER

NOVEMBER 1988

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NEW AFFILIATES

Fusion Power Associates welcomes the following companies as Small Business Affiliates:

Doty Scientific Inc., 600 Clemson Rd., Columbia, SC, 29223. Dr. F. David Doty will represent the company. He can be reached at (803) 788-6497. Their areas of interest include first wall design and cooling and closed Brayton cycle heat engines.

Supercon, Inc., 830 Boston Turnpike, Shrewsbury, MA, 01545. Dr. Eric Gregory will represent the company. He can be reached at (508) 842-0174. Their areas of interest include superconducting materials.

Thermacore, Inc., 780 Eden Road, Lancaster, PA, 17601. Donald M. Ernst will represent the company. He can be reached at (717) 569-6551. Their areas of interest include heat transfer and high heat flux cooling.

TRIVELPIECE TO HEAD ORNL

Dr. Alvin W. Trivelpiece, co-founder of Fusion Power Associates and currently executive officer of the American Association for the Advancement of Science, has been named director of Oak Ridge National Laboratory and a vice president of Martin Marietta Energy Systems. He will assume full responsibilities on or before January 1, 1989. In making the announcement, Clyde C. Hopkins, president of Martin Marietta, said of Trivelpiece, "His strong scientific and engineering credentials will ensure the commitment to high standards within the laboratory, and his personal character and leadership will provide new direction for ORNL." Trivelpiece succeeds Alex Zucker, who has been ORNL acting director since Herman Postma, the previous director, became

NEW ORNL DIRECTOR ALVIN W. TRIVELPIECE (r.) RECEIVED SPECIAL AWARD FROM FPA IN 1987 FROM FPA PRESIDENT STEPHEN DEAN

Martin Marietta Energy Systems senior vice president in February 1988. Trivelpiece was the recipient of a Special Award from the Fusion Power Associates Board of Directors in 1987, recognizing his many career accomplishments. We wish him every success in his new position.

INTERNATIONAL ICF GROUP FORMED

An international "Society for Inertial Fusion," whose primary purpose is to "suggest steps and devise a policy for international programs and international cooperation" in inertial fusion research has been established. According to an announcement, "membership in the society will be open to scientists from all around the world who are interested in ICF." To join, or for further information, contact Guillermo Velarde, director, Catedratico de Fisica Nuclear, Instituto de Fusion Nuclear, Universidad Politechnica de Madrid, E.T.S. Ingenifros Industriales, Jose Gutierrez Abascal 2, Madrid, Spain, 28006. Telephone 411-41-48.

ITER NEWSLETTER

The International Atomic Energy Agency (IAEA) will publish a monthly newsletter on the conceptual design activities of the International Thermonuclear Experimental Reactor (ITER). Called the "ITER Newsletter," copies are available without charge from the ITER Council Secretariat, IAEA, P.O. Box 100, A-1400 Vienna, Austria. The first issue is dated September 1988. Paul N. Haubenreich, of ORNL, is serving as Secretary of the ITER Council in Vienna and is responsible for issuing the newsletter. John Clarke is chairman of the ITER Council.

BOOK PUBLISHED

The Physics of Laser Plasma Interactions, by William L. Kruer, 182 pages, is available for $37.95 from Order Dept. Addison Wesley Publishing Co., Jacob Way, Reading, MA, 01867, (617) 944-3700.

TOKAMAK TRANSPORT TASK FORCE ESTABLISHED

Following up on the recommendations of the MFAC Summer Study (see our September newsletter) the DOE Office of Fusion Energy is establishing a Transport Task Force under the chairmanship of Jim Callen of the University of Wisconsin. The charter for the group and its membership are not quite finalized. Jim has prepared an outline of how he proposes to organize and topics he proposes to address. Copies are available from Jim at the Dept. of Nuclear Engineering, Engineering Research Bldg., 1500 Johnson Drive, University of Wisconsin, Madison, WI, 53706, (608) 262-1370.

LINFORD KEYNOTES FPA SYMPOSIUM

Rulon Linford, director of the magnetic fusion program at Los Alamos National Laboratory, gave the keynote address at Fusion Power Associates annual meeting and symposium in Santa Fe, September 6-8. The theme of the FPA symposium was "Creating Compact, High Power Density Fusion Plasmas." In his address, entitled "At a Crossroads for Fusion: A Time for Important Choices," Linford said that "We should carefully reassess our priorities for the likely situation that no better than flat budgets will be available for fusion in the next several years." He posed three options for consideration: 1) "Construct the Compact Ignition Tokamak (CIT) by reducing the base program; 2) delay the construction of CIT until additional funds are obtained; and 3) replace CIT with another lower-cost focus for the U.S. program." He noted that over the past few years of design of the CIT, "as the debate proceeded about size and cost versus mechanical stresses, ignition margin, and scientific flexibility, I watched the major radius grow from about 1.2 m up to the present value of 2.1 m." With respect to program balance between conventional tokamak research and more advanced concepts, Linford said, "If the real potential for these concepts is ever to be known an environment needs to be provided, even in times of tight budgets, that would allow those concepts with the most reactor promise to advance step by step, based on scientific progress and understanding."

With respect to the three options he posed, he chose option 2, calling it "the one that has been articulated by Harold Furth for nearly two years." He noted that the most recent review of the fusion program by the Energy Research Advisory Board contained the following sentence in the transmittal letter to Energy Secretary Herrington:"Furthermore, the Board agrees that the funding to support the vital base program over the next five years should remain approximately constant, and that funding for fusion should be supplemented with incremental funds for design, construction, and operation of CIT."

Copies of Rulon's talk are available from Fusion Power Associates.

RUTH WATKINS CITED BY FPA BOARD

The Board of Directors of Fusion Power Associates presented a certificate of appreciation to Ruth A. Watkins, at the annual board meeting in Santa Fe, September 7. The certificate cites Ruth for her "dedicated service and many professional contributions as vice president for administration and finance."

ERRATA

A wrong phone number was listed for Nick Krall and Krall Associates in our October newlsetter. The correct number is (619) 481-7827.

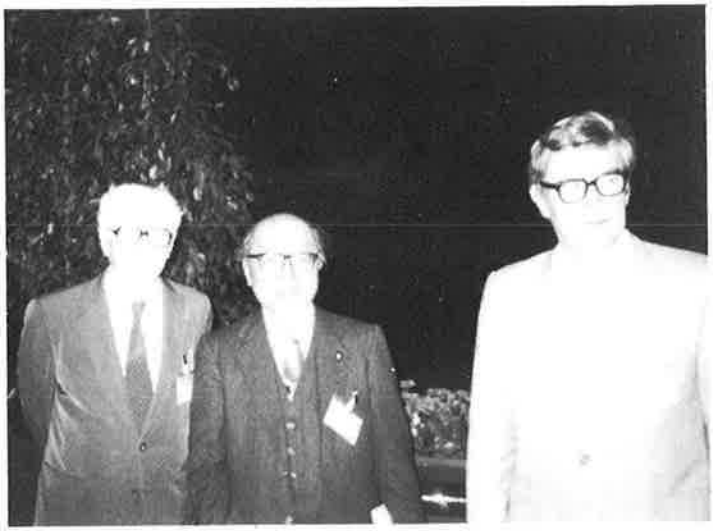
MIKE ULRICKSON WINS FPA ENGINEERING AWARD

Dr. Michael A. Ulrickson of Princeton Plasma Physics Laboratory has been selected by the Fusion Power Associates Board of Directors to receive our Excellence in Fusion Engineering Award in memory of Prof. David J. Rose. The award recognizes Mike for his outstanding technical accomplishments and leadership in the development of graphite tiles for use in tokamaks. The award was presented at the FPA annual meeting in Santa Fe on September 6.

ABDOU WINS ANS AWARD

The Fusion Energy Division of the American Nuclear Society awarded its Outstanding Achievement Award for 1988 to Prof. Mohamed A. Abdou of the Mechanical Aerospace and Nuclear Engineering Department at UCLA. This award is the most prestigious award of the Fusion Energy Division of the ANS and is presented to an ANS member in recognition of exemplary individual achievement requiring professional excellence and leadership of the highest caliber.

The award recognizes Abdou's "Outstanding contribution to fusion science and engineering, including pioneering research contributions in nuclear analysis and technology, innovative developments in reactor design, and exceptional leadership of the FINESSE project, the US-Japan program on fusion neutronics, the Blanket Comparison and Selection Study and the STARFIRE and ANL-DEMO conceptual design studies. The award was presented to Prof. Abdou during the Fusion Topical Meeting on October 12, 1988.



PALUMBO, HUSIMI, PEASE (l. to r.) RECEIVE FPA DISTINGUISHED CAREER AWARDS

The Board of Directors of Fusion Power Associates has announced the selection of three persons to receive the association's Distinguished Career Awards, in recognition of their outstanding, career-long, accomplishments in fusion science, technology and administration.

The three are: Kodi Husimi of Japan, Donato Palumbo of Italy and R. Sebastian Pease of the United Kingdom.

The awards were presented by Dr. Stephen O. Dean, president of Fusion Power Associates, at the 12th International Conference on Plasma Physics and Controlled Nuclear Fusion Research in Nice, France, on October 14.

In presenting the awards, Dr. Dean noted the key roles that each has played in the success of the fusion programs in Japan, Europe and the United Kingdom, respectively. But in addition he praised the three for their contributions to the world effort through their service on the International Fusion Research Council (IFRC) of the International Atomic Energy Agency (IAEA). The IAEA has been, and continues to be, a dominant force in assuring international fusion cooperation. The success of the IAEA fusion activity is in large measure due to the efforts of Husimi, Palumbo and Pease over many years, Dean said.

Husimi was director of the Institute for Plasma Physics, Nagoya University and is currently a member of the House of Councillors of the Diet of Japan. Palumbo recently retired from his position as direc-

tor of the fusion program of the Commission of the European Communities. Pease recently retired from his position as director of the Culham Laboratory in England.

Fusion Power Associates' Distinguished Career Awards were established to recognize individuals, in the later part of their careers, who have made lifelong contributions that have had major impact on fusion development. The awards were presented for the first time in 1987. The 1987 recipients were Melvin Gottlieb, Donald Kerst, Richard Post and Lyman Spitzer, Jr.

ARGONNE HOSTS SCIENCE TEACHERS WORKSHOP

The Fusion Power Program at Argonne National Laboratory hosted a workshop Oct. 28-29 for 45 secondary school science teachers. The workshop entitled "Fusion Energy and Classroom Applications" featured presentations from Steve Dean (FPA), Charlie Baker (ANL), Bill Hogan (LLNL), Bob Bourque (GA) and Mujid Kazimi (MIT).

PEOPLE

Howard Jory, manager of gyrotron engineering at Varian Associates' Microwave Tube Division has been named a Varian Fellow, based on his role in designing and building the first gyrotron microwave tubes for U.S. fusion energy applications. 100 times more powerful than conventional microwave tubes, gyrotrons are used to heat the hydrogen gas or plasma that fuels fusion reactions. The gyrotron engineering department that Jory established continues to design tubes with increasingly higher power levels. Varian manufactures nearly all of the gyrotrons used in fusion energy research in the free world, including those in Europe, Japan and the U.S. Two other scientists working on microwave tube development were also named Varian Fellows. They are Armand Staprans and Lou Zitelli. The Varian Fellow program is designed to recognize the company's top technical achievers and give them opportunities to impact the technological future of the company in new ways.

Neil Todreas has been elected to the National Academy of Engineering. He is professor and head, Department of Nuclear Engineering, Massachusetts Institute of Technology. Election to membership in the National Academy of Engineering is a singular honor given to distinguished engineers by their peers. Todreas was honored for his fundamental contributions to the understanding of fluid flow and heat transfer in nuclear fuel assemblies.

Charles A. McDonald, Jr. has rejoined the Lawrence Livermore National Laboratory as associate director at large. McDonald first joined LLNL in 1954, but since 1973 has been working at R&D Associates in Marina del Ray, CA, where he has been a vice president since 1977. In making the appointment, LLNL director John Nuckolls said that McDonald would assist him in a variety of assignments and principally in the management of the weapons and inertial fusion programs.

Phil Coyle has been named principal laboratory associate director and acting laboratory executive officer and Jim Davis has been named associate directors for Lasers at LLNL.

Jack Dugan, long-time staff director for the House Science, Space, and Technology Committee's subcommittee that oversees the magnetic fusion program is leaving for a position in private industry. We wish Jack well in his new career and thank him for his constant support of the fusion program over many years.

STUDENT AFFILIATES

Fusion Power Associates has established a category of participation called Student Affiliates. For annual dues of $10, students can receive our mailings and begin to become actively involved in fusion happenings.

MEETINGS

December 5-9 11th International Conference on Lasers '88, Lake Tahoe, NV. Contact P.O. Box 245, McLean, VA, 22101, (703) 642-5835.

January 14-19 AAAS Annual Meeting, San Francisco. Contact AAAS Annual Meeting Registration, Room 830, 1333H Street, NW., Washington, D. C., 20005.

January 15-20 OE Lase '89, Los Angeles, CA. Contact SPIE, Box 10, Bellingham, WA, 98227-0010, (206) 676-3290.

January 15-20 Combined APS-AAPT Joint Meeting. San Francisco. Contact APS, 335 East 45th St., New York, NY, 10017.

DECEMBER 1988

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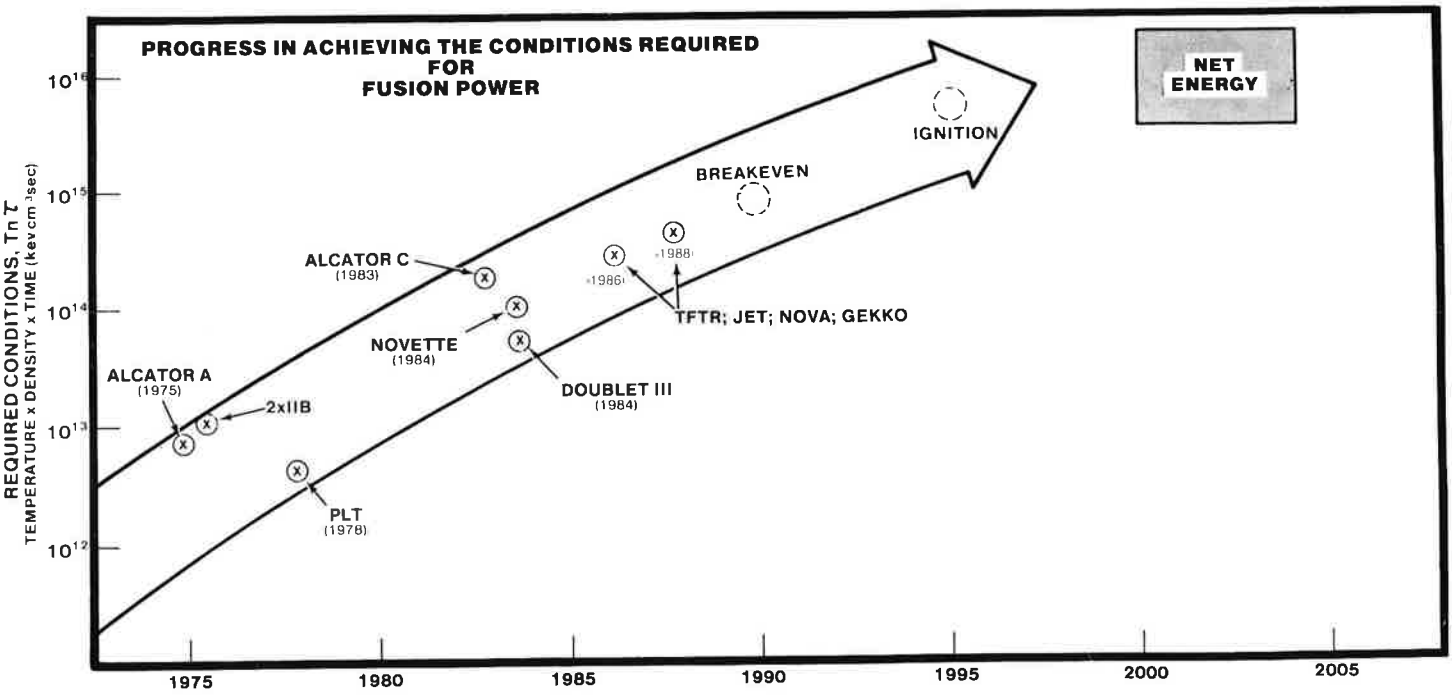
FUSION PROGRESS

Over 600 scientists from 41 countries gathered in Nice, France, for the 12th biennial conference on Plasma Physics and Controlled Nuclear Fusion, sponsored by the International Atomic Energy Agency (IAEA).

The conference was opened by Dr. Charles Massonier, the European fusion program director, who presented the keynote address, called the "Artsimovich Memorial Lecture."

Massonier noted that there were 3 billion people in the world when fusion research began, there are 5 billion now, and that there would be 8 billion people when fusion will be ready to be deployed in the next century. "As to the question of when will the first fusion power plant be built," Massonier quoted Academician Artsimovich: "When there is great need for it." Massonier stated that by careful engineering design, combined with the development of low activation materials, fusion reactors could satisfy the public requirements for an economically attractive and environmentally benign energy source. He noted that the product of plasma density times temperature times confinement time, "the best figure of merit" for fusion progress, has increased by a factor of 10,000 over twenty years and that there was only now a factor of four to go to "breakeven" and a factor of slightly more than ten to ignition. "The completion of the scientific phase of fusion is now in sight," Massonier said. "The next step in fusion should be taken as soon as technically feasible." "If we work hard, this would be early in the 90's," he said. He predicted that a commercial fusion demonstration reactor could be operational in about three decades.



Tokamaks

Participants in the conference were anticipating new results from TFTR (US) and JET (Europe) the two large tokamaks which are approaching the achievement of "breakeven" conditions, wherein the fusion energy produced would just equal the energy input to the plasma. Unfortunately, neither TFTR nor JET has yet reached breakeven. TFTR reported about three-tenths of breakeven; JET reported about one-quarter of breakeven.

TFTR and JET are operating in different plasma confinement regimes. TFTR is operating in the so-called "supershot" regime characterized by very high temperature. Record high central ion temperatures of 32 keV (about 320 million degrees) were reported. With central density of $8.7 \times 10^{13} cm^{-3}$ and confinement time of about 0.15 seconds, TFTR reported a record high value of the product $n \tau T$ of about $4 \times 10^{14} cm^{-3} sec$ keV. This is about twice that reported two years ago. JET reported comparable values of $n \tau T$ of about $3 \times 10^{14} cm^{-3} sec$ keV. In the case of JET, however, the temperature was lower (8 keV). JET continues to hold the world record for confinement time, 1.2 sec.

Important results from the DIIID tokamak at General Atomics were reported in which they tested theoretical models of achieving high values of the parameter "beta," the ratio of fusion plasma pressure to magnetic confining pressure. DIIID verified the model over a wide range of beta values and reported a world record high value achieved of 6.8%. A value of 8% or more is considered necessary for a commercial reactor.

Inertial Fusion

Scientists from the University of Rochester reported achieving compressions of fusion fuel to 100-200 times liquid density using a 1.5 kJ laser pulse directly impinging on a pellet. The laser light at a wavelength of 3500 nm is divided into 24 beams. Sixty to eighty percent of the light energy is absorbed by the pellet. Rochester has proposed an upgrade of their facility to a 60 beam, 30 kJ system. Calculations indicate that ignition of the pellet fuel might just be possible in such a system, Rochester scientist Bob McCrory said.

Scientists from Osaka University in Japan also reported achieving fuel compression of over 100. Compressions of about 1000 are required for ignition. Osaka scientists predicted that about 100 kJ is required for ignition, using direct illumination of the pellet with a uniformity of 3%. Currently the Osaka laser, GEKKO XII, has a 15 kJ capability. A 100 kJ laser upgrade has been proposed by Osaka.

At the Lawrence Livermore National Laboratory (LLNL), the laser light is first converted to x-rays which then implode the fuel capsule. This requires less control of the illumination uniformity. LLNL implodes pellets, also to over 100 times liquid density, using 20 kJ of 3500 nm light. Nova will operate soon at 50 kJ of 3500 nm light. In a pellet containing a low density of fuel, LLNL symmetrically compressed the pellet by a factor of 30 in radius. A factor of 40 is required for ignition with higher fuel density.

LLNL also stated that fuel capsules had been irradiated in underground nuclear weapons tests and that these results gave them high confidence that inertial fusion was scientifically feasible.

STUDENTS WIN AWARDS

The APS Division of Plasma Physics has awarded the 1988 Simon Ramo Award for Outstanding Doctoral Thesis Research in Plasma Physics to Alan Hugh McCurdy, currently at the U.S. Naval Research Laboratory, noting that his thesis has "fundamental implications for nonlinear oscillator physics in general and practical importance for the development of high power RF sources for plasma heating."

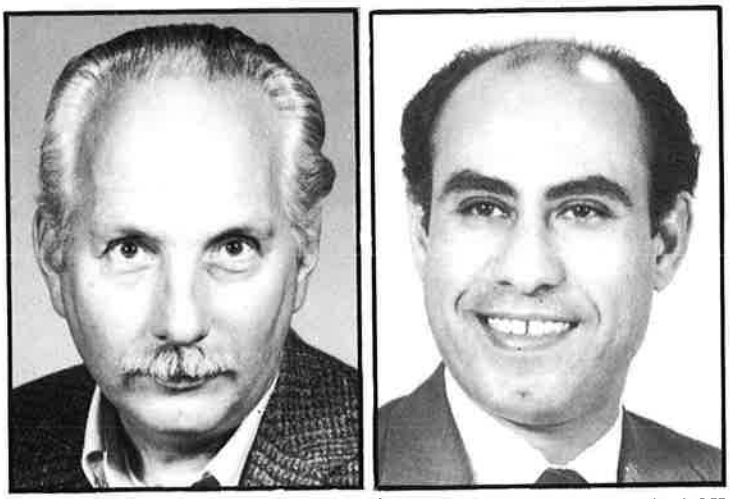
The ANS Fusion Energy Division has presented its 1988 Student Award to Semian Sukoriansky, who received his doctorate at the Ben-Gurian University of the Negev, Israel, for his theoretical and experimental studies of turbulence in liquid metals flowing in the presence of strong magnetic fields.

OTA STARPOWER REPORT CITED

The Office of Technology Assessment's fusion report "STARPOWER" won second place in the category of Publications for Technical Audience (One Color)" from the National Association of Government Communications. There were over 1000 entries in the contest. Our congratulations to the study directors Gerald Epstein and Dina Washburn.

ANS HONORS KRAKOWSKI, ABDOU

The Fusion Energy Division of the American Nuclear Society awarded its Outstanding Achievement Award for 1988 to Robert A. Krakowski of Los Alamos National Laboratory. This award is the most prestigious award of the Fusion Energy Division of the ANS and is presented to an ANS member in recognition of exemplary individual achievement requiring professional excellence and leadership of the highest caliber. A parallel award was also presented to Prof. M. Abdou of UCLA (see our November newsletter). The award recognizes Krakowski's "outstanding contributions in the area of fusion reactor systems studies and specifically for being a forceful advocate of compact, high power density reactor embodiments." In addition, the award states that Bob "has rendered outstanding service to the fusion program through participation in activities such as ESECOM and the FED of ANS, having been past chairman."

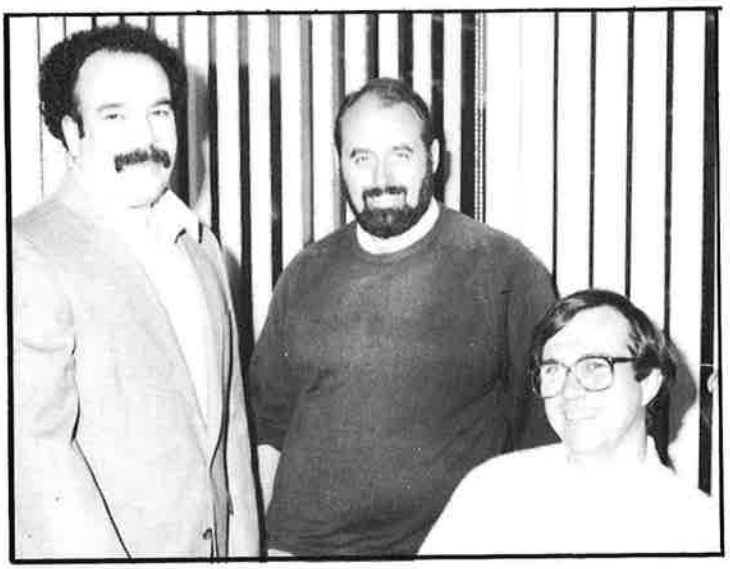


ROBERT A. KRAKOWSKI (1.) AND MOHAMED A. ABDOU
ANS AWARD WINNERS

APS HONORS ROSTOKER, GOLDSTON, HAWRYLUK AND STRACHAN

The Division of Plasma Physics of the American Physical Society has awarded the 1988 James Clerk Maxwell Prize in Plasma Physics to Norman Rostoker of the University of California, Irvine, "in recognition of his pioneering theoeretical contributions to the statistical mechanics of particles with Coulomb interactions; to the treatment of inhomogeneities, fluctuations, and Larmor radius effects in plasmas; and his oustanding leadership in both experimental and thoeretical research on the acceleration of electrons and ion beams and their interactions with plasmas."

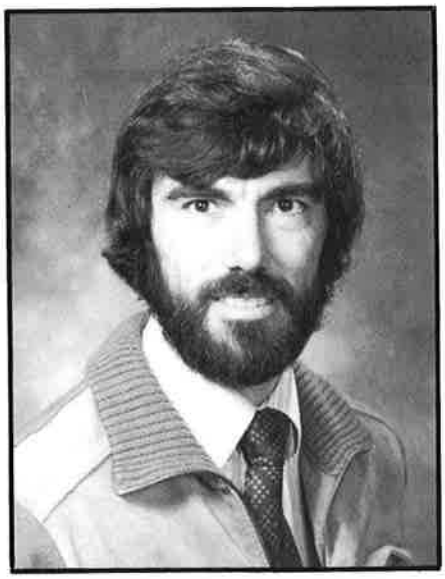
The Division also awarded the 1988 APS Award for Excellence in Plasma Physics Research to Robert J. Goldston, Richard J. Hawryluk, and James D. Strachan of Princeton Plasma Physics Laboratory, "for the discovery and scientific exploration of enhanced confinement plasmas with ion temperatures in excess of 20 keV in the Tokamak Fusion Test Reactor."



ROBERT J. GOLDSTON, JAMES D. STRACHAN AND RICHARD J. HAWRYLUK (1. to r.), APS AWARD WINNERS

SALTMARSH NAMED FUSION A.D. AT ORNL

Michael J. Saltmarsh has been named associate director for operations in the Oak Ridge National Laboratory's Fusion Energy



MICHAEL J. SALTMARSH
ORNL FUSION DIVISION A.D.

Division. Mike will assist director John Sheffield in administration of the division and in overseeing the division's major projects including the operation of ATF, ORNL's new stellarator. Lee Berry will continue to serve as associate director for technology.

EBASCO WINS PRINCETON CIT CONTRACT

An industrial team headed by Ebasco Services Incorporated (Ebasco) was awarded a multi-year contract by Princeton University to supply the Compact Ignition Tokamak (CIT) vacuum vessel system. The scope of work includes the research and development, design, engineering, procurement and installation/testing support for the following CIT subsystems: divertor systems, first wall assembly, vacuum vessel assembly, and in-vessel remote maintenance system. Ebasco will provide the overall program management and the vacuum vessel assembly. Two major subcontractors to Ebasco, McDonnell Douglas Astronautics Company and Spar Aerospace Ltd., will be responsible for the development of the high heat flux components and the in-vessel remote maintenance systems, respectively. Additional assistance will be provided by other industrial participants, including SAIC, Telerobotics International, Remotec, Vetco-Gray and Process Applications, Inc.

The principals in this industrial team include Ebasco's Robert Iotti (VP, Advanced Technology), William Reddan (Program Manager) and John Warren (Vacuum Vessel Assembly Manager); McDonnell Douglas' Dale DeFreece (Manager, Nuclear Systems), John Davis (Manager, Fusion Programs), John Haines (Divertor Systems) and Harold Mantz (First Wall Assembly); and Spar Aerospace's Peter Stafow (VP, Remote Manipulator Systems Div.) and Peter Lucas (Remote Maintenance Systems).

FUSION PRODUCTIONS

Fusion Power Associates has been assisting several private groups producing fusion films for public television and schools. New Jersey Network has completed a one-hour public television special called "The Sun of Man," which aired in the Trenton, NJ, area on October 6. It is expected to be shown nationally in January or February. One unique element in this film is that the producers visited the USSR, obtaining interviews with Sakarov, Golovin and Strelkov, as well as a U.S. interview with Velikhov. For information contact the producer, Mark Levinson, at (609) 530-5128.

FPA is also working with Manifold Productions to produce a one-hour fusion documentary for South Carolina Educational TV. The film is scheduled for completion in Spring of 1989. Manifold Productions recently produced an outstanding public television special entitled "America's Political Parties," which aired nationally in two parts on October 17 and 18. For information contact the producer, Michael Pack at (213) 851-3773.

National Geographic is producing a 25-minute fusion film for high schools. Fusion Power Associates has been serving as a script consultant. We recently viewed the beginning of the editing process. The film will have a good mixture of animation, interviews and facilities. For information contact Donald Cooper (202) 857-7673.

FPA has also been contacted for advice and assistance in producing a fusion segment as part of a TV series on the Impact of Science and Technology on Society. For information contact Sam Marantz, president, South Florida Public Telecommunications, P.O. Drawer 6007, West Palm Beach, FL, 33404.

REPORT AVAILABLE

Reprints are available from FPA of an article entitled "The Coming Age of Fusion Power," published by FPA president Steve Dean in the October 1988 issue of Leaders Magazine.

FUSION FACILITIES DIRECTORY AVAILABLE

The 1988-89 Fusion Facilities Directory is now available from Fusion Power Associates. The Directory has phone numbers of fusion personnel working at 44 institutions, including government, national laboratories, industry and universities. It contains useful information such as mailing and delivery addresses, fax numbers, hotel accommodations, organization charts and local maps. The cost is $20.00 per copy (U.S. and Canada) and $30.00 per copy (overseas-surface) or $40.00 per copy (overseas-airmail).