Most touching for me, is the dedication at the end of the film to a dear friend, Dr. J. Gordon Edwards. He fought the lies about DDT through great personal sacrifice, and the film is a fitting tribute to his memory.

There are many zingers in the film, that will surprise even the DDT literate. But I will leave it to you, readers, to find out by seeing the film, buying the DVD when it becomes available, and getting this important documentary shown to schools and community groups.

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* The summary statement of the hearing administrator can be read on the *21st Century* website.

Stuart Lewis/EIRNS

Entomologist J. Gordon Edwards speaking at the National Press Club in May 1992, at a press conference commemorating the 20th anniversary of Ruckelshaus's decision to ban DDT for "political" reasons.

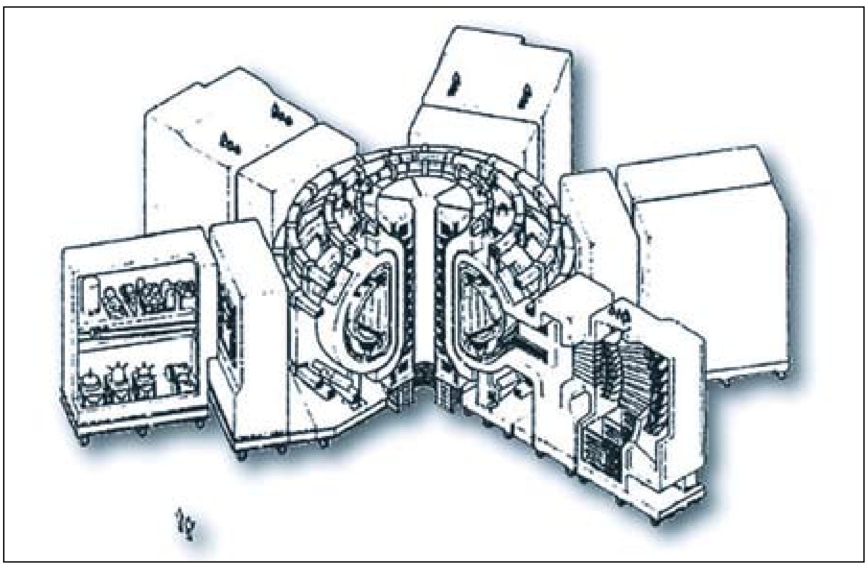
Fusion's Long Road to ITER

by Stephen O. Dean

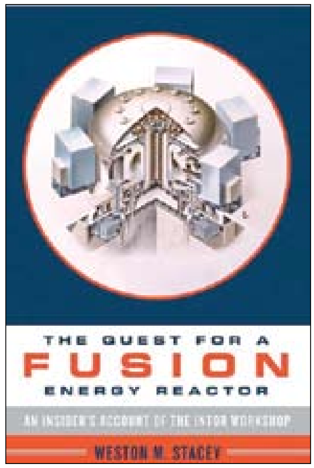
The Quest for a Fusion Reactor: An Insider's Account of the INTOR Workshop
by Weston M. Stacey
New York: Oxford University Press, 2010
Hardcover: 188 pp., $24.95

The Arab oil embargo (October 1973-March 1974) caused many countries to seriously question their dependence on Middle East oil as a dominant energy source. In the United States, this took the form of rapidly increased funding for research and development of alternative energy options. At the United States Atomic Energy Commission, the U.S. fusion program (then called Controlled Thermonuclear Research), under the direction of Robert L. Hirsch, was one of the beneficiaries.

When Hirsch took the helm of the fusion program in early 1972, he wanted to move the fusion program from research into development and deployment as rapidly as possible. As director of the largest of three divisions reporting to Hirsch, I prepared a decision tree, dated October 1972, describing a plan that included operation of a Physics Test Reactor by 1984, an Experimental Power Reactor by 1991, and a fusion power Demonstration Plant by the year 2000.



A 1980s design study, for the Intor Experimental Tokamak Reactor.



When the oil crisis hit, fusion funding was increased from its FY 1973 level of $40 million to $332 million in FY 1978 to a high of $469 million in FY 1984. The Physics Test Reactor, which we named the Tokamak Fusion Test Reactor (TFTR), was authorized in the FY 1976 budget, and began operations in 1983. A similar facility, the Joint European Torus (JET), began operations also about that time.

While these physics test reactors were under construction, attention began to be given to the conceptual designs of the Experimental Power Reactor (EPR) and fusion power plants. In the mid-1970s, author Weston Stacey led a team at Argonne National Laboratory that produced conceptual designs of two EPRs. Other EPR designs were carried out by Mike Roberts at Oak Ridge National Laboratory and by Charlie Baker at General Atomics. Stacey's book traces the history of the international effort to design an EPR, starting in 1978 under the auspices of the United Nations International Atomic Energy Agency (IAEA). That EPR was given the name INTOR, an acronym for INternational TOkamak Reactor.

INTOR eventually merged into ITER (International Thermonuclear Experimental Reactor), now under construction in France as an international venture, but not scheduled for operation until 2019. Stacey's book provides a compelling narrative on how the schedule for the EPR started to slip and is now 30 years later than the 1990 date hoped for in 1972.

Weston M. Stacey, more widely known as Bill, is Callaway Regents Professor of Nuclear Engineering at Georgia Institute of Technology. As leader of the U.S. INTOR team, and vice chair of the international group responsible for the INTOR effort (1978-1988), he is well qualified to write this account, and he does so in an authoritative, thorough, engaging, and candid manner.

Stacey kept meticulous notes of his interactions with both the technical team and government officials. He pulls no punches in describing resistance on the part of some to the study and changes in the political landscape. National interests and policies frequently came in conflict with the desire of the INTOR team to move the project expeditiously from design and R&D to construction.

Nevertheless, there is no denying that, without the INTOR work, collaboration on the design and construction of a fusion engineering test reactor would likely not have been a credible proposal to lay on the table when President Reagan and USSR Secretary Gorbachev agreed to collaborate on fusion during their Summit Meeting in Geneva in 1985.

A Collaborative Effort

The INTOR study was a collaborative effort among the United States, Japan, Soviet Union, and Europe, under the auspices of the IAEA. The chairman was Sigeru Mori from Japan, with Stacey as vice chair. But if there is a hero in this account, it is Evgenii Velikhov, head of the Soviet fusion program, who proposed the INTOR study to the IAEA in the first place, and who steadfastly expressed the support of the Soviet Union for INTOR construction, when the other parties were giving mixed messages, or having financial crises, within their own government programs. It was Velikhov who brought the collaboration to the attention of Secretary Gorbachev, in advance of the 1985 Summit Meeting with President Reagan.

Wilson photo collection, Harvard University Physics Department

Evgenii Velikhov (left) with Edward Teller and Richard Wilson, at the Erice meeting in 1983. Velikhov, the head of the Soviet fusion program, proposed the INTOR study to the IAEA and continued to support its construction.

The goal of the INTOR study was to assess the readiness of the world's fusion programs to undertake the design and construction of the first experimental fusion energy reactor, to define the research and development that would be necessary to do so, to develop a design concept for such a device, and to identify and analyze critical technical issues that would have to be overcome.

Stacey's book describes both the detailed technical evolution of the design and the administrative and political issues that plagued the project. A major issue throughout was the ambivalence among the heads of the fusion programs in the various countries about whether their national program goals would be better served by focussing on construction of national EPRs, rather than an international project. This ambivalence was especially characteristic of the U.S. leadership, according to Stacey.

The INTOR Workshop was launched in November 1978. By October 1979, the team had come up with rough estimates of the cost of an EPR, ranging from about $1.5 billion (E.U. and U.S.) to $2.3 billion (Japan). In a 650-page report, the group also concluded that it was scientifically and technologically feasible to undertake the construction of INTOR initially, to operate about 1990, provided that the supporting R&D effort would be expanded immediately to provide an adequate database within the next few years in a number of important areas.

Although the leaders of the national fusion programs endorsed the findings, it was clear that they were not prepared to undertake commitment to an international construction project. The INTOR design continued to be refined, until the ITER project was launched (also as a design study) in 1988.

The goals of the U.S. fusion program, to operate an EPR by 1990 and a demonstration power plant by 2000 continued to look possible throughout the 1970s, culminating in the passage in October 1980 by the U.S. Congress of the Magnetic Fusion Energy Engineering Act of 1980, which made these goals national policy.

A Major Downshift

Stacey's book describes the major change in U.S. energy policy following the election of Ronald Reagan as U.S. President in November 1980. He notes Congressional testimony in the Spring of 1982 describing the new U.S. fusion policy as to develop the database for fusion, allocating to industry the demonstration of fusion as an energy source. This policy derailed the goals set in 1972 as codified in the Magnetic Fusion Energy Engineering Act of 1980.

While ITER is now aimed at many of the original EPR goals as an international venture, a timetable for a demonstration power plant remains obscure.

In 1988, the ITER venture began. Originally, at the 1985 Reagan-Gorbachev Summit Meeting, it appeared that the two had agreed on a relatively rapid process leading to construction. As it turned out, however, construction did not begin in earnest until 2009, more than 20 years later.

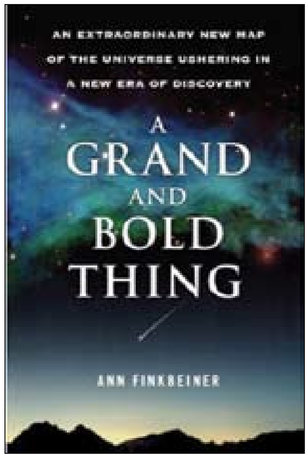
Stacey's history ends in 1988, with the handoff of the INTOR design work to the new ITER team. Many of the INTOR participants joined the ITER design team, including Ken Tomabechi (Japan), who became the first ITER design team director. The 20-year history of ITER preparations (1988-2009) appears in secondhand reports in the trade press and elsewhere, but a candid insider's history, such as the one Stacey has provided for INTOR, remains to be written.

I highly recommend this book to all those involved in fusion research, administration, and policy. It is well written, in an engaging style, while also being unusually candid and thorough. Well-done and thanks, Bill Stacey.

Stephen O. Dean is the president of Fusion Power Associates.

The Story of the Sloan Digital Sky Survey

by Laurence Hecht



A Grand and Bold Thing: An Extraordinary New Map of the Universe Ushering in a New Era of Discovery
Ann Finkbeiner
New York: Free Press, 2010
Hardcover, 223 pp., $27.00

The author devoted three or more years to interviewing the participants and doing the research to document this great achievement in observational astronomy, which is now accessible to all on the Internet. Some of the nation's leading astronomers and an army of code writers, many of them graduate and undergraduate students in the field, put together the system for utilizing a 2.5 meter (98-inch) telescope at Apache Point, N.M. to make the largest sky survey ever assembled, including more than a million galaxies.

My disappointment was not in the description of how the project came to be, but in the interpretation of its results, which sticks a bit too obediently to standard cosmological assumptions. The modern, zipped-up style of science writing also proves a distraction. Is this really what it takes to sell books these days, or are the writers merely degrading themselves in pursuit of a will-o'-the-wisp of public approval?

The Sloan survey was the brainchild of James Gunn, an accomplished astronomer, cosmologist, and master instrument designer, who conceived it in the 1970s and spent most of the 1990s helping to bring it to fruition. Fermilab, Princeton, the University of Chicago, and a number of other leading universities participated, with initial funding from the Sloan Foundation.

A Network of Superclusters

The photographs and spectrographic data have contributed to our understanding of the structure of the universe, at least in the visual spectrum. When combined with a smaller visual survey, 2dF, run out Cambridge University, the maps showed an ordering to the galaxies that had not been known before.

Galaxies form in clusters which are part of superclusters. These superclusters, in turn, are not isolated in clumps but are parts of a universal network, filaments of lights that are denser or thinner and sprawl over sheets that fold themselves around dark voids. It looks like solidified lava, or a sponge, or medically imaged tissue. It is biological, geological, natural—just the way you would expect the universe to look.

Google Sky and WikiSky utilize the Sloan maps for the approximately one-quarter of the celestial sphere that they cover, and fill in the rest of the sky with other less intensive surveys. WikiSky attempts to integrate the view of the sky in different wavelengths, including the ultraviolet and infrared. An International Virtual Observatory Alliance is attempting to oversee the production of detailed multi-wavelength archives, including the gamma ray, X-ray, ultraviolet, visual, and infrared spectra.

I found Chapter 7, The Virtual Observatory, to be the most fun. Part of the unusual agreement in the project had been that after a year, all data would go into the public domain, via the Internet. That decision has already revolutionized the field, in which access to telescopes and proprietary nature of data had heretofore been a severe restriction. Today, anyone can access the Sloan digital archive, simply by searching for SkyServer on the Internet. Once there, a huge wealth of information is available to any who wish to learn how to use it.

There have been 713 million hits on the Sloan archive since the first public release of data in June 2001; currently it has 60,000 to 70,000 different users a month, many times more than the number of professional astronomers in the world. Some of these are volunteers who are using the Sloan archive to participate in a project known as the Galaxy Zoo, to help classify the millions of galaxies photographed by the Sloan Survey. Computers are not as good as humans at the complex shape recognition and interpretation required for this. There are 272,000 "zooites," as the participants in the Galaxy Zoo project call themselves.

Dusty Beginnings

The idea of enlisting the public in such programs originated with a NASA project called Stardust@Home, which drew in 24,000 people to examine Internet images of 40 million dust grains collected from a comet's tail and brought back to Earth. The idea was to see if any of the grains looked unusual and might have come from outside the Solar System.