AIP|Matters

July 30, 2012

» Subscribe
» Contact
» Give Feedback
» Archives

Director's Matters

By H. Frederick Dylla, Executive Director & CEO

How long is the fuse on fusion?

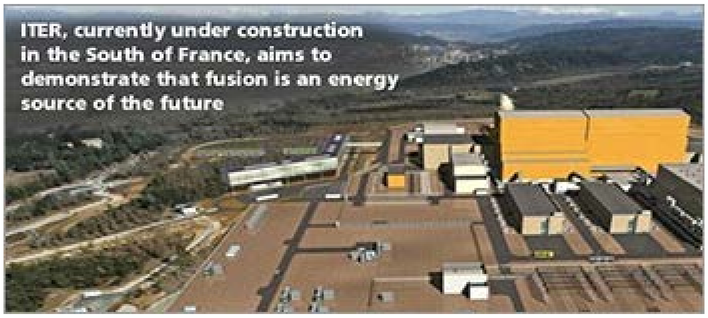
The Washington Post recently ran a cover story in its Science section on fusion energy, with a photo showing a physicist peering through the porthole of an experimental magnetic fusion device at Princeton Plasma Physics Lab (PPPL). I began my scientific career at this DOE laboratory in 1975—just two years after a national energy crisis with rationed gasoline and four years before the accident at Three Mile Island. These events were rallying cries for the development of clean and renewable domestic energy sources.

At that time, fusion energy was little more than a pipedream with no prospect of contributing to the nation's energy supply in the foreseeable future. Nevertheless, the prospect of the United States leading the development of harnessing the same energy source that powers the Sun helped expand national funding for fusion research during the next decade. Europe, the Soviet Union, and Japan also undertook massive billion-dollar-class demonstration experiments. When the U.S. flagship experiment, the Tokamak Fusion Test Reactor (TFTR) at Princeton, was shut down in 1997, the DOE had spent $8 billion over 45 years on fusion research—more than expenditures on any other energy technology. What do we have to show for this investment? Are we any closer to the day when fusion can contribute to central power generation?

When I began working at Princeton as post-doctoral fellow in 1975, there was a long way to go to reach that point. The energy produced in the lab was about a trillionth of the energy required to heat the gas. By 1995, the energy gain had been improved by a factor of 100 billion. And in the mid-1990s, the TFTR at PPPL and the JET Tokamak, a sister experiment in the U.K., performed a series of experiments with the easiest hydrogen isotopes to fuse (a deuterium and tritium mixture) and came within 30% to 65% of the breakeven point! This was a remarkable scientific achievement because it involved a continuous evolution of the design and implementation of solutions needed to better heat, contain, and fuel the hot gas.

I can point to only one other technical endeavor that has shown such a large improvement in key performance parameters. Most people know it as Moore's Law. The continuous improvement of microprocessors is largely due to miniaturization of transistors. Advancements in microelectronics manufacturing technology have enabled the size of a transistor to decrease by about a factor of two every two years. Intel made the first microprocessor chip commercially available in 1971—the 4004 contained 2,300 transistors. Today's chips contain more than 2.6 billion transistors.

A laboratory demonstration—one engineered to generate electric power for decades with minimal downtime and affordable maintenance. The promise of fusion always appears on the horizon.



As I write this, a fusion facility that will cost more than $10 billion, ITER, is being built by an international consortium (European Union, Japan, Russian Federation, United States, Republic of Korea, China and India) in Caderache, France. This device is planned to begin operation by 2019, and scientists plan to demonstrate 500 million watts fusion power for several minutes duration a decade later. This may sound like a slow, slogging pace when considering the world's constantly growing demand for energy. DOE and numerous study groups make periodic attempts to construct national and international long-term energy strategies. These plans never appear to be able to influence the entrenched trillion-dollar interests in hydrocarbon-based energy sources. Moreover, with the fiscal realities of energy production and global debt crises reining in research budgets, it's a challenge to make a case for funding a long-term solution like fusion research.

This creates a painful reality for the DOE and the U.S. fusion community. Yet I strongly believe that our 60-year investment in this "holy grail of energy sources" has made tremendous progress, and is positioned to make a major step forward. The nation should find a way to sustain a critical mass of both domestic and international investments. The ultimate goal is so attractive that the U.S. should not lose the opportunity to be a leader in the international fusion program.

When I was involved with fusion research, I was often asked what motivated me to work on this difficult problem, even though I would probably never see a satisfactory solution in my lifetime. I didn't have to ponder this question very long. The yearly progress from the '70s into the '90s was exciting enough. I was fortunate to cut my scientific teeth on the challenging problem of fusion research. Such scientific endeavors need to be nurtured worldwide given the scale of investments required for frontier research, and the United States needs to reinvigorate its leadership role.

Publishing Matters

JCP's *Spotlight Collections* Section Highlights Semiclassical Theory in Molecular Dynamics

Scientists studying the dynamics of molecular collisions would like to capture quantum mechanical effects without having to solve the sometimes impossibly complex Schrödinger equation. This challenge is the topic of *The Journal of Chemical Physics'* most recent Perspective article in the *Spotlight Collections* section. In a podcast on the JCP website, William H. Miller, professor emeritus of chemistry at the University of California at Berkeley, describes how semiclassical theory provides a systematic way of adding quantum coherence to classical molecular dynamics. Miller notes that while much of semiclassical theory was developed in the '60s and '70s, the last decade has seen its growing application to more complex molecular interactions. JCP's *Spotlight Collections* section features invited papers on current topics of interest to the physical chemistry research community, as well as audio interviews with researchers. The papers highlighted in the series are among the most downloaded papers from the JCP site.

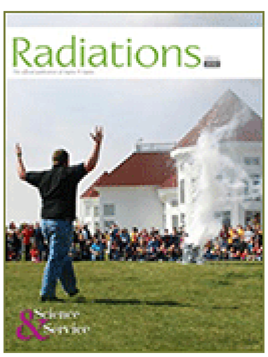
Physics Resources Matters

The Sound of the Bomb

Film and videos of nuclear explosions are almost always dubbed. What does a nuclear explosion actually sound like to a person on the ground? Alex Wellerstein of the Center for History of Physics has found and posted on his "Restricted Data" blog rare footage from a Cold War nuclear test that addresses this question directly. The footage of the March 17, 1953, "ANNIE" test has murky visuals, but crisp, unedited audio, unlike most nuclear test films (which are usually dubbed in post-production). With a good pair of headphones on, one can hear murmurs of soldiers and newsmen before the blast countdown starts. The camera "sees" the explosion about 30 seconds before the audible blast wave arrives, because the camera is 11 kilometers away from the explosion. As the fireball is rising, a sharp "bang" can be heard, followed by a long, thundering roar as the blast wave echoes off of the nearby mountains. The crowd can then be heard to shout out spontaneous expressions of awe. The footage is a rare example where the sound of the blast has not been edited to be simultaneous with the actual explosion, giving a more realistic impression of the on-the-ground experience.

Wellerstein enlightens readers about how the speed of sound affects what witnesses hear after a nuclear detonation.

Off the Press



Spring issue, 2012: "Why should honor societies ask their members to do anything beyond achieving good grades?" Outgoing Sigma Pi Sigma President Diane Jacobs of Eastern Michigan University poses this question in a special issue of *Radiations* magazine devoted to "Science and Service." The entire issue delves into the service mission of Sigma Pi Sigma, complementing the theme of the upcoming 2012 Quadrennial Physics Congress.

Member Society Spotlight

U.S. Physics Team returns home with accolades from the Olympiad

Travelling members of the U.S. Physics Team returned home after nine days of intense competition in Estonia, host country of the 43rd International

Physics Olympiad. So, how did these high-school students fare in their quest for gold? To find out, see AAPT's 2012 U.S. Physics Team webpage.

Coming Up

July 28–August 1

- ACA Annual Meeting (Boston, MA)
- AAPT Summer Meeting (Philadelphia, PA)

Tuesday, July 31

- Ice cream social and "WOW" drawing, 2:30 pm (College Park, MD)
- Marcum Workplace Challenge, 7 pm. A 3.5 mile run/walk, accompanied by Long Island's largest office picnic (Jones Beach State Park, NY)

July 29–August 2

- AAPM Annual Meeting (Charlotte, NC)