Japan is ahead in laser fusion

U.S. physicist John Cox reports on his surprising findings during a recent tour of research facilities at Osaka University.

Laser physicist John Cox was a speaker at an April 22-23 conference in Tokyo on the Strategic Defense Initiative, sponsored by the Fusion Energy Foundation and the Schiller Institute. Dr. Cox is the president of Future Tech., located in Gainsville, Florida.

Dr. Cox was a research scientist at the University of Florida, and worked for U.S. Army Ballistic Missile Defense and for the National Aeronautics and Space Administration on the development of high-energy nuclear-powered lasers (1978-82).

While in Japan, Dr. Cox was able to visit the laser research laboratory at Osaka University. He discussed his observations and evaluation of the Japanese laser fusion program with Marsha Freeman.

Let me preface my statement by saying that I have visited Los Alamos [National Scientific Laboratory] as well as the Lawrence Livermore laser laboratory, and I've seen what we have here in the U.S., so my observations will be put in the context of comparing what we have here. I fell victim to typical prejudicial thoughts: that the Japanese were incapable of doing unique or novel research; that their bailiwick was taking what we had pioneered and making it cheaper, faster, better—but not necessarily doing anything novel. With that mindset, I went into this laser fusion laboratory, looking to see pretty much a duplicate copy of what we had done in the U.S.

The very first thing that was rubbed in my face, was that while their philosophy about their research was somewhat different, they had accomplished things that we will probably never be able to do. These accomplishments have a lot to do with their dedication to progress and cooperation with industry. The connection with industry in Japan was a much tighter system, and industry was taking an active role in the research. In the United States, laser fusion work is made up of isolated pockets of research. With the classification that is hanging over this research, there's a lot of wasted and duplicate effort here. In Japan there is an open society between research and industry, and the progress they've made is fantastic.

The main thrust of the laboratory is still basic physics. They were not doing any studies actively to look at fusion reactors, to find out how you take this fusion energy and convert it to electricity at an economical price. That seemed to be a secondary or tertiary consideration. They were primarily looking at this as a research tool to study the physics of fusion. Their main thrust is to optimize the coupling between the energy in the laser pulse and the target, and that remains, in my opinion, one of the greatest challenges of laser fusion.

They were working on novel target designs and systems which would automate the procedure, and make the results more reproducible. They had an automatic focusing system which I was very impressed with. They're bringing something on the order of 15 laser beams, of a meter in diameter, all coming to bear on a target that is less than a millimeter in diameter, all within a nanosecond, which is a billionth of a second.

The ability to bring to bear that kind of power, within that short a time-frame and those spatial dimensions, is very impressive. They are trying to get a trillion-neutron yield, which means that during a single pulse they would generate a trillion neutrons from a fusion burn. That is an achievement that I don't think we've duplicated in the United States. They're able to do that, time and time again. One of the most frustrating things I've come across in research, is that it is difficult to reproduce something if it is very complex. The Japanese were able to get uniform results, which is very critical in terms of understanding cause and effect.

Another feature about the laser institute which impressed me, was that they've been in business there for 20 years, and over that 20-year period, they have developed between seven and nine laser systems, each being successively more powerful, more accurate, etc. In the U.S. we've had a similar progression of technologies from the 1960s to now. But in the U.S. when we build a better system, we cannibalize and disassemble the old system. At the laboratory in Japan, they had all of the laser systems completely operational and functioning at the same time.

You might say, well, what good is that? You've got old stuff that's no longer of interest. But when you're training a new generation of laser or nuclear physicists, it's very valuable to let them gain experienece on the other machines, and bring them along the same way the technology has been brought along. This is an incredible teaching resource, a learning tool for future scientists. That would be a paradise to me, if I were able to conduct classes or teach students in an environment like that; that would be a dream come true, to have that many systems available at one time.

Problem areas

They do have some problem areas that they are struggling with now. They have one of their latest systems up and running and they're getting a lot of information out of it and making a lot of progress. But in order to maintain that level of progress, they are having an employment crunch. This is a consequence of their philosophy of life.

Like all big organizations, the research laboratory has a localized need for labor, that is not a permanent need. For instance, they are just now finishing their implosion system. They need a lot of people to work on the diagnostics. They would like to hire 10 or 15 research scientists or engineers who are very knowledgeable about diagnostics.

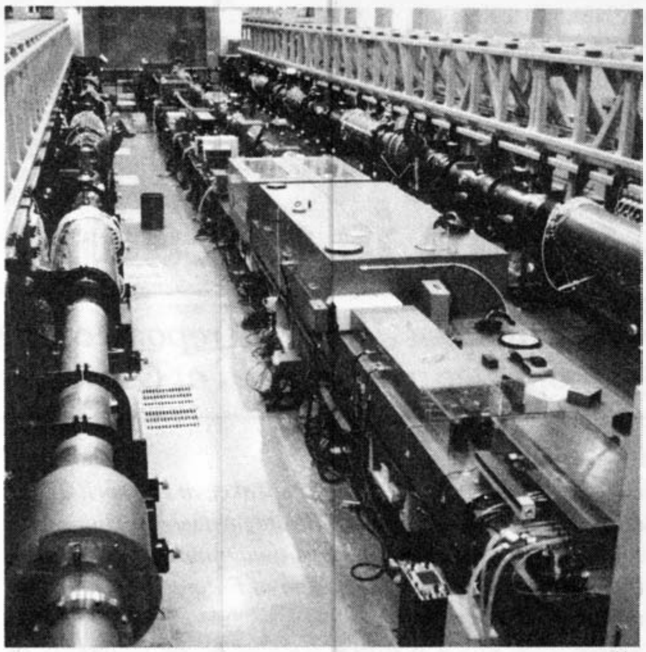
The problem they are having is that if they hire on someone at a university institute in a government position, that position is normally a position for life. But they only need him for a couple of years, and they cannot justify the expense of bringing on these extra staff people for a short time. I simply asked the head of laboratory, why don't you hire contractors, as we do in the United States? The contractor knows he has a job to do, and when it's over, he goes.

The director replied that it went beyond the regulations and the laws; he himself, as an administrator, could not look the guy in the eye three years from now, and tell him he's fired. It wasn't just the fact that they didn't have the money; the tradition had affected even the management and the top-level staff.

They are making an effort now, with the Diet [parliament—ed.], to open up these temporary positions—to create a new position, a temporary worker, who would be moved around.

I said, why don't you hire foreign contractors? I'd love to come over there and work for three years on your diagnostics and then leave. He said that they are considering that, too. The other benefit you'd get from hiring foreign contractors, is bringing in new blood, new thoughts, new ideas to invigorate the program. He said it is going to be a slow process.

The one area of technology where they are not as current as we are, was in the area of diagnostics. They were still using very crude diagnostic systems to acquire the data. I can't say that they're any less accurate or reliable in their data because of it. The newer technology would not make the detectors or systems intrinsically better; it would make them faster, increase their productivity. They're working on that now.



NSIPS

The Gekko glass laser at Osaka University's fusion research laboratory.

They are going to have to import some of that technology from the United States. The reason why the U.S. has that technology, is that the military has sensor technology which is very critical military technology, which we have spent billions of dollars on. We are the leaders in this area. If Japan had a defense budget, they would have an equal array of technology.

Scientific spinoffs

Though people talk about spinoffs into the private sector from this kind of technology, what is not mentioned, is the spinoff into scientific technology, which is even more obvious and straightforward. Our scientific research benefits 100-fold over what the private sector gets. Military research benefits private and industrial *research* far more than it benefits the commercial work of the private sector. The military research also pays overhead and other intangible things. I can't think of any major research effort that does not have at least some military contracts, which pay for the "basic necessities of life."

How that applies in the Japanese situation is not clear; but what is clear, is that those same scientists working on the problems of solving laser fusion, would also be swept up into the military-oriented research on the Strategic Defense Initiative, and there are a lot of common goals. They overlap so much, that it's difficult to disentangle them.

I'll give you a perfect example. I did work on a high-energy laser system for NASA that was not a military-funded research effort. However, I was doing the same work for NASA that I was doing for the military, so here you have a complete overlap in the basic research. As basic research evolves into technology components and hardware, then you have a parting of the ways. In basic physics, laser fusion physics, the overlaps are enormous, and that's why our basic research is so good.

How classification cripples science

In the Japanese laser fusion laboratory, the contractors in private industry were able to work hand-in-hand with research scientists in a government facility. Here in the U.S., you have this classification network that shunts all of this information, and you have isolated pockets of people who don't communicate with each other.

It's like a synergy there. If everyone knows the same information, then the problems can be solved from within. Here, everything is isolated. For instance, in the Japanese research lab, they were doing everything in-house. They had a total capability in-house, which means they were making the pellets there, they had a complete facility to rebuild and repair their own laser systems. They do have contractors come in to support that effort, but they were doing everything there. Here, the pellets are made in Ann Arbor, Michigan by a private company, on contract with the federal government. The particles are shipped down to the labs, and the actual research and data comes out classified.

And here, even within the same laboratory, the information is not shared. The absurdity of this really strikes home when you realize that the Japanese are doing research in areas that we haven't gotten to yet. They have tried to publish the results of their work, and no U.S. publication will accept it, either because the work is not being done at all yet here, and no one can decide if it's good or not; or because the material is classified here and the Japanese are publishing what would be considered classified data, in the U.S. It's ridiculous. And that's just because of our closed society system. The information is not allowed to flow freely in this area.

When the laser fusion program in the U.S. first got started, it started producing data that was relevant to weapons, such as the so-called "EMP effect" or electromagnetic pulse. Scientists discovered that the magnetic fields propagating out from the explosion led them to re-write all of the bomb codes; it changed everything. The program got a big shot in the arm. Here was a tool that enabled them to do essentially mock-up explosions of microexplosions, enabled them to improve their models of explosives and design better weapons. That's where it all got classified.

Commercial spinoff potential

I raised the question of commercial spinoffs from laser science with the director of the laboratory, Dr. Sadao Nakai. He said that there was virtually no effort to speak of in looking at commercialization of the product. He tended to avoid the discussion about commercialization or anything to do with any other application other than basic physics. He did point out that they are trying to spin this technology off in other ways than just power.

That's what KMS Fusion in Michigan has done. The micropellet technology has spilled over to the private sector. They are making micropellets for pharmaceuticals, for cancer therapy research. This technology "oozes" spinoffs. The Japanese are not as eager or capable of spinning off this technology. That's not what drives them. That requires somebody's being a product champion, saying, "I'm going to get this company going." That American spirit is subdued there. That entrepenurial spirit is there, but it is subdued.

Let me say a word about classification. I gave a paper at a conference—I was working on an optical processor for the Air Force and was funded at the University of Florida. We were trying to develop robotic machine vision using a new principle of optics. It's the same principle that the insect eye uses, a surface processor instead of a volume processor. In other words, our eyeball needs a volume—it has a focal length, and a diameter, and an aperture. An insect eye is a skin basically; it has no volume. We were developing optical sensors based on what Mother Nature invented millions of years ago. I was giving a paper at a conference and the Air Force had submitted an abstract of the paper.

I flew all the way out to California to give the paper, in 1983, and they withdrew my paper and classified it. And I said, "Why? This is basic physics. What good is this going to do the Russians?" They said, "Look, we just paid $100,000 for this data. I don't want the Russians to have it, for the cost of a conference seat." They withdrew my paper, because they did not want the Russians to pay for an air fare and a conference fee, to get the same information they had just paid $100,000 for. That totally changed my perception of why things are classified.

The Japanese said that they had spent $300 million on the laser facility, and I assume that includes everything they've got up to today, that's the value of their assets. It's difficult to make dollar-for-dollar comparisons. When you spend a dollar in Japan, how does that compare to what you could get for that same dollar here? I have to place uncertainty on that $300 million figure, plus or minus 50%.

They also teach there, so I don't think I could place a number on the people who are just dedicated to research. You typically spend $100,000 per man, and if they had an annual budget of $10 million, they would have about 100 employees there. A research scientist is paid about $30,000 but in order for him to work, he consumes another $70,000 in overhead, equipment. They're getting a lot of mileage out of their money. They've already got $300 million in it, and that's a sizeable investment of any sort. I don't think you will find that investment in any of the two U.S. labs.

If the U.S. would wise up and at least transfer information back and forth between the two programs, there would be an enormous benefit to us. I don't know how it would happen. The SDI would certainly open the door, and get the thing rolling. If the Japanese would just get involved with defensive-type technology in general, the spinoffs that they would have, would be enormous.