Asian Nations Forge Ahead in Fusion

by Marsha Freeman

Over the past year, great progress has been made on the ITER (International Thermonuclear Experimental Reactor) being built in France, which is designed to demonstrate the scientific feasibility of producing thermonuclear fusion energy. At the same time, China and South Korea have advanced their own plans to take the next step, to demonstrate the technology and engineering requirements for future electric generating fusion power plants. Europe and Japan, although on a less aggressive timetable, are also planning for the steps beyond ITER. As was repeatedly noted during the December 2014 annual meeting of Fusion Power Associates (FPA) in Washington, it is only the United States that has no plans for the future of fusion, and, in fact, is barely holding on to its shrunken domestic program.

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Dr. Wan Yuanxi

At the FPA meeting one year ago, leaders of the Chinese and Korean fusion programs described the early stages of their long-term planning activities. This year, they reported, they have formulated plans, and are presenting them to their respective governments for approval and funding. Both countries are heavily involved in international cooperation, and see collaboration on ITER as critical to the development of their own research. Meanwhile, in Washington, the Senate has threatened to withdraw the United States from ITER altogether, due to schedule delays and cost increases in the U.S. program.

During his FPA presentation, Dr. G.S. Lee, the "father" of Korea's tokamak program, explained that one reason he was in Washington, was to go to Capitol Hill, in order to "defend and protect ITER." Having studied in the United States, and worked as a fusion researcher here, Dr. Lee is acutely aware of the changes in the U.S. in recent decades.

In an interview with this author, Dr. Lee said that whenever he comes to Washington, he "always stops over at the Smithsonian Air & Space Museum. Then, I am standing in front of the Apollo program, and John F. Kennedy is talking about it." He said he does that "to remember this, and rejuvenate our thinking, that this is the way we have to develop humankind, in this direction." But in the U.S. now, "it has slowed down.... The frontier spirit is lost," he said. The culture has become "decadent."

Dr. Lee's concern that the United States could drop out of ITER is well-founded. Resolving critical questions in fusion science is the goal of its experiments. But to develop fusion into an energy technology will require meeting both the scientific and engineering challenges. This is the step China and Korea are getting ready to take.

Planning the Next Step

In his presentation at the FPA meeting, Academician Wan Yuanxi, Dean of the Department of Nuclear Science & Technology at the University of Science & Technology in Heifei, China, and former director of the Institute of Plasma Physics of the Chinese Academy of Sciences, reported that when the University department he heads was founded five years ago, the Chinese Ministry of Science and Technology made a decision to fund a national design group, to create a road map leading to the next step for fusion research in China, which Dr. Wan was asked to head. The next-step machine is designated the Chinese Fusion Engineering Test Reactor (CFETR). Dr. Wan convened a group of ten prominent scientists and engineers, to, within three to four years, come up with a design for the project.

"Just two weeks ago," Dr. Wan said in our interview, "more than 200 scientists and engineers got together to summarize our progress for the engineering conceptual design. I was happy," he said. "Many young people gave the presentations at the meeting." The group will now discuss a "more detailed engineering design for the CFETR" and prepare to present it to the government. During 2015, additional key R&D requirements for CFETR will be defined. "It is hoped the proposal for CFETR construction can be approved soon," to start around 2020, to be completed in ten years.

Dr. Wan explained in his presentation that this step

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An artist's rendering of a conceptual design of the China Fusion Engineering Test Reactor (CFETR). The inset is a cross section of the tokamak.

is needed to develop and test technology challenges, such as material that can withstand the fusion environment, a lithium blanket that can breed the tritium fuel for the fusion reaction, guaranteeing the safety of the reactor, and providing high-efficiency electricity generation from the fusion energy. Without tackling these challenges, it will not be possible to move to demonstrating successful operation of a fusion power plant. At the same time that China is contributing to the construction of ITER, Chinese fusion scientists are also asking the government to increase support for their domestic experiments.

Dr. Lee reported at the meeting on progress toward the next-step machine in the South Korean fusion program, which is also focused on technology and engineering development, and is designated KDEMO (Korean Demonstration Fusion Power Plant). He said that a new building has been completed at the National Fusion Research Institute, to house the KDEMO design team. He summarized the technology programs underway in Korea, and stressed that they have an "aggressive" plan. They will not wait to start KDEMO until they see if ITER works.

Dr. Lee reported that within days, the fusion leadership would be going to the federal government and to Congress to request $600 million for a six-year technology development program, to start in 2019. In preparation, there is a request for a $10 million per year effort, over three years, to identify the fusion technologies that will require the most effort, and to identify the technology gaps between ITER and KDEMO.

The Fusion 'Asia-3'

In the first week in December, there was a workshop in China, bringing together fusion scientists from China, South Korea, and Japan, in what Dr. Lee described as the "A-3." The *ITER Newsline* reported that the discussions included fusion and ITER, but also "synergies in terms of culture," and, looking forward, a session, "Beyond ITER."

In our interview, Dr. Lee explained that the three Asian nations "have a bond of culture and history." Because of recent history, he said, especially during World War II, there are political problems, but "those are for politicians."

"We want our fusion programs to be complementary," he explained. "China has lots of resources, but they have less development and fewer people that are teaching at a high level. Japan is very much developed, but they are less active. And Korea is somewhere in between. . . . If you have countries in heterogeneous development phases, if you consolidate and work together, you will find that the gaps can be filled much more easily."

The problem in the U.S. program, Dr. Lee asserted, is leadership. It was "people like George Washington and Lincoln and [Franklin] Roosevelt and John F. Kennedy, a sequence of leaders, that made this nation great."

Dr. Wan recalled that on President Xi Jinping's visits to the Institute, he agreed on the need for fusion development, telling the scientists: "You are doing very important work for the future of human beings." Xi observed that in the last 200 years, America "developed very quickly because the American government encouraged people to invent something," Dr. Wan said. President Xi "doesn't like to take care of small things. He likes [big projects like] the New Silk Road," Dr. Wan explained.