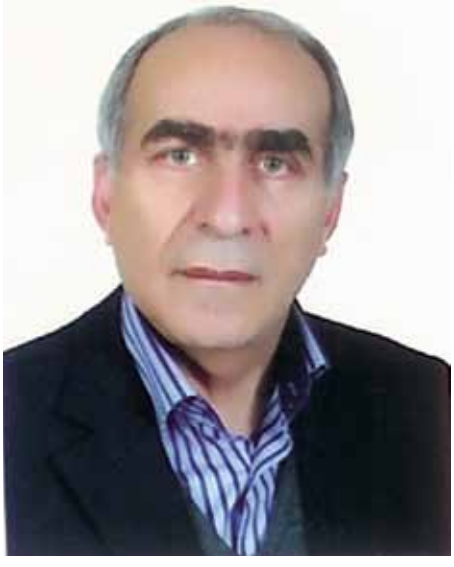
Iran's Contributions to World Fusion Research Poised for Take-Off

by Marsha Freeman

Sept. 5—The July 14 nuclear agreement between Iran and the P5+1 nations of China, France, Germany, Russia, the United Kingdom, and the United States will remove sanctions and other barriers, and create the opportunity to fully integrate scientists in Iran into global scientific research. One field of research that is specifically mentioned in the agreement, is the great challenge of all of humanity—nuclear fusion energy. Iran's direct participation in the front-line International Thermonuclear Experimental Reactor (ITER), which is under construction in France, is noted in the agreement as a possibility.



Dr. Mahmood Ghoranneviss

The contributions that Iran has made to move fusion research forward remain unrecognized even among most members of the world's scientific community. It is critical now to mobilize all of the world's scientific resources to bring about the transition to a fusion-based world economy.

Iran has a vibrant and growing fusion energy research program, which includes various approaches to fusion, and many fields of applications of plasma technology. Reaching the goal of developing fusion technology for large-scale energy production, fusion scientists agree, is greatly enhanced by international cooperation.

Over the past month, Iranian fusion scientist Dr. Mahmood Ghoranneviss has provided answers to questions about Iran's fusion research program, posed to him via email by *EIR* Technology Editor, Marsha Freeman. Dr. Ghoranneviss has provided the photographs of Iran's IR-T1 Tokamak, which help to illustrate the program's accomplishments, and point to the pathways for cooperation in the future.

Dr. Mahmood Ghoranneviss is Dean of the Plasma Physics Research Center of the Science & Research Branch of the Islamic Azad University, located northwest of Tehran. In 1994, Dr. Ghoranneviss inaugurated the Research Center and since then, has led the fusion research program in Iran. The Center is the most advanced of its kind in Iran, in plasma physics, training, and research and development in nuclear fusion.

Dr. Ghoranneviss is also Director of the *Journal of Theoretical and Applied Physics*, associated with Azad University. The Journal is open and free of charge to all readers and authors. He has published in, and been guest editor of, a number of international scientific journals. He is the author of 28 books, holds patents in Germany and the United States, and has contributed to 334 scientific papers.

EIR: Dr. Ghoranneviss, please tell us about your background, and major areas of research.

Ghoranneviss: I earned my Bachelor of Science from Tehran University, Iran, in 1977, a Master of Science in 1980, and doctoral degree in plasma physics in 1988, from Poona University in India.

I began my research at the Atomic Energy Organization of Iran in the Plasma Physics Research Group in 1983, and a decade later, in 1993, founded the Plasma Physics Research Center. I have developed and equipped 12 advanced physics laboratories for research

in a variety of areas. These have included fusion approaches such as the plasma focus and inertial confinement fusion, and applications such as chemical vapor deposition, the plasma torch, the low-temperature plasma jet, and low-power lasers. My main area of research has been in magnetic confinement fusion, and I also developed industrial and medical applications of plasmas.

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Iran's IR-T1 tokamak is contributing to global fusion research under the small tokamaks program of the International Atomic Energy Agency. Here, an aerial view.

EIR: Iran, it is well known, is an oil-rich country. Why, then, is Iran pursuing a fusion energy program?

Ghoranneviss: Since Iran's resources are not permanent, we need to look for new energy sources, such as fusion energy. Iran's plan is to have clean fusion power for the future.

EIR: What are the main magnetic fusion experiments in Iran?

Ghoranneviss: The IR-T1 tokamak, which focuses on the development of diagnostics, and the study of MHD [magnetohydrodynamic] instabilities in plasmas. In 1994, the IR-T1 tokamak was purchased from China. The machine stands 2.5 meters tall, with a weight of 2.7 tons, and a radius of the toroidal chamber of 45 centimeters. Since 2006, there is also a Plasma Focus Laboratory at the Center, which houses three devices, which are homemade.

EIR: I understand Iran participates in international fusion research with the IR-T1 tokamak. How does this research contribute to the international ITER tokamak program?

Ghoranneviss: The ITER project is facing many challenges. In order to solve the problems of fusion, small tokamaks in different countries are used, because working with a small tokamak is much easier, and is affordable. IR-T1 focuses on diagnostic plasma parameter mesurements, and MHD instabilities, which are important for ITER.

Since 2006, we have had two contracts with the IAEA [International Atomic Energy Agency of the United Nations] to carry out research which supports ITER. These contracts are under the Coordinated Research Project of the IAEA, which supports joint research using small tokamaks, for theoretical and experimental studies that can be applied to ITER.

EIR: I would think that Iran's participation in internatioal fusion research has been affected by the Western sanctions. Is this the case?

Ghoranneviss: Yes. During these years, we faced so many problens due to the sanctions. Most of the time, we could not attend the important conferences, due to visa rejections. (In my case, I applied for a U.S. visa, but my visa got rejected). In some cases, we could get a visa, with much difficulty, but then during the conference and laboratory tours, conference organizers did not let us visit their labs and setups. Another problem is in buying the things that we need for our

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Diagnostic instruments inserted inside the tokamak provide scientific measurements of plasma parameters and behavior.

center from developed countries, such as material, setup, and measurement systems: They simply don't sell to us! Some journals also do not publish papers from our country.

EIR: How many people are working in plasma physics and fusion research in Iran?

Ghoranneviss: We have about 100 scientists who are working on fusion research in Iran, and there are more than 150 PhD students working on plasma and fusion topics. More than 150 papers from our University have been published by our graduate students in fusion.

In total, there are more than 1,200 students at our Center, including 800 undergraduate students, in laser physics, plasma physics, soild state physics, and 200 Masters of Science students in comparable fields.

On August 22, I reported that the Plasma Physics Research Center is recruiting postdoctoral researchers in fusion energy and plasma technology. This program

Ten Years of Progress

The Iranian program has accomplished the following disagnostic up-grades to its IR-T1 Tokamak over the decade 2005-2015.

1. Installation of a new data acquisition system with 144 channels
2. Timing and triggering systems have been upgraded
3. Upgrading of 42-channels amplifier to amplify signals from the IR-T1 Tokamak
4. Design and fabrication of 40 channels integrator with time constant (1ms, 4ms, 10ms)
5. Design and calibration of 3 high-precision rogowski coils to measure the main fields of the IR-T1 Tokamak
6. Replacement of all vacuum systems according to the latest standard
7. Design and fabrication of limiter bias system for impressment of the bias voltage to plasma in the IR-T1 Tokamak
8. Installation of a high-purity hydrogen generator
9. Design and construction of a Feedback system to control the horizontal displacement of plasma in the IR-T1 Tokamak
10. Improvement of all high voltage relays
11. Design and fabrication of a movable Langmuir probe
12. Maintenance of resonance helical field (RHF) system in IR-T1 Tokamak
13. Design and fabrication of 16-channels Rack probe
14. Design and fabrication of a Movable limiter
15. Design and fabrication of Mach probe to measure plasma radial speed in IR-T1 Tokamak
16. Installation of Reseal Gas Analyzer (RGA)
17. Design and fabrication of Ball pen probe.

is being supported by the Iran National Science Foundation.

One of our current projects is to design and fabricate a superconducting tokamak, as a national project.

EIR: Could you describe your Center's research work with the plasma focus? This is a very promising approach to fusion, and is being studied with more advanced fusion fuels, to produce aneutronic reactions, that is, without producing damaging neutrons. It has also involved some interesting international collaboration.

Ghoranneviss: The Plasma Focus Laboratory at the Center was established in 2006, and includes research and development, and the training of manpower. In research on the plasma focus, we have projects with the United States, China, and Australia.

We have been collaborating with Lawrenceville Plasma Physics (LPP) in New Jersey, on plasma focus research, under a contract signed in 2012. The two laboratories agreed to collaborate in the publication of scientific papers, exchange of ideas for plasma focus designs, share the results of research and simulations, and the joint supervision of PhD student theses.

We are still taking our first steps, and have not published any results yet, but we are designing, and now fabricating the set-up for the experiments.

EIR: You have developed some very interesting applications drawn from fusion research, using low-temperature plasmas, electron beams, and other spin-offs. Can you describe these?

Ghoannevis: We have designed and built two electron beam systems, which can be applied to lithography in the microelectronics industry; in the food industry, for packaging products; in welding, melting, and evaporating materials; as well as the sterilization of medical equipment.

We have developed applications for plasmas in medicine. This is a relative newcomer to this field. We have developed a "Plasma Needle," that uses a low-temperature and low-power plasma. This plasma can be used for sterilization, disinfection, in dentistry, and other applications. Plasma medicine is rapidly developing. We have already started much experimental research in this new field.