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*Illustration of the industrial science complex for radiation-based technologies, being constructed near the Advanced Radiation Technology Institute.*

INTERVIEW: DR. YOUNG-JIN KIM

# Unique Nuclear Center Is a Backbone for Industrial Growth

*Dr. Young-Jin Kim is Vice President of the Korea Atomic Energy Research Institute (KAERI) and Director General of Advanced Radiation Technology Institute, Republic of Korea. The interview took place on June 14, 2011 at the International Meeting on Radiation Processing in Montreal, Canada. Kim was interviewed by* 21st Century *correspondent Matthew Ehret-Kump.*

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*Dr. Young-Jin Kim*

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***21st Century:*** **You mentioned the very interesting industrial-science complex that will be constructed in South Korea near your facilities. What does the Korean Atomic Energy Research Institute hope to accomplish with this plan, both for South Korea and the world at large?**

**Kim:** The Korea Atomic Research Institute is the sole institute concerned with the research and development of nuclear technology. It is located in Daejeon, where the science park was already formed some 30 years ago, when our government decided to install the Advanced Radiation Technology Institute in Jeongeup city. This is around one-and-a-half hours driving distance south of the Daejeon headquarters.…

About two years ago, it was decided that Jeongeup city, which is 1,000 years old, would be the location of an industrial complex, and now they are preparing the land, so that companies will build their factories here.

About 10 years ago, our government made a plan to improve the regional economy and make it grow in tandem with the central capital in Seoul, the Seoul metropolitan area. Seoul is where most of the money, most of the jobs and the companies are located. So our growth pattern is quite biased.

In the countryside, agriculture is the most important industry. Do you know how difficult it is to gain any economic benefit by growing rice, corn, or vegetables? So this is the area where we were located five years ago. This institute was created five years ago, after the previous five years had been used to make special laws as well as the planning; finally this institute was founded and opened in 2006.

We do a lot of research and development in the area of industrial materials as well as environmental technologies. Our efforts are also on the biotechnologies using irradiation. We have one department where we can use radiation to make mutations, so that we can develop new plants and new flowers.

***21st Century:*** **You said that there are already similar industrial science complexes throughout South Korea, but that this one is unique. How?**

**Kim:** It is unique because this one is based on radiation. The other industrial complexes are mostly electronics, car manufacturers, steel manufacturers, information technologies. Those are just some examples, but this is unique because the radiation technologies are based on many different kinds of radiation instruments, such as the cyclotron emissions, gamma rays, electron beams. These beams are used to produce new types of material, or new radioisotopes, and new materials.

For example, for artificial hip-joints, we have new polymers that can be made harder and have a greater longevity. These are made using gamma rays. Also hydro-gels for burn-wound dressings. We also make space food. We sent our first astronaut using the Russian rocket, and she carried this irradiated food up, and they had a party in space. So our research areas are quite diverse.

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*The Advanced Radiation Technology Institute in Jeongeup, where Dr. Kim is the director general. The Institute will be designated as an IAEA regional training center for South East Asia.*

***21st Century:*** **You mentioned that this research facility is working to attract various creative minds from across Eurasia, to collaborate together to share ideas and discoveries.**

**Kim:** Yes, that is our goal. But right now, we will be designated as an IAEA (International Atomic Energy Agency) training center, and regional training center for the Regional Cooperation Area that covers South East Asia. This means we will be training and educating the scientists from Southeast Asian countries like India, Pakistan, Indonesia, Malaysia, Thailand, Vietnam, and some in China, Ukraine, and Mongolia.

Those scientists from about 20 countries come over to our institute to get one to two weeks in training courses, and then they return to their home countries. The program is determined by the IAEA. They decided which programs would be planned for this year, then they informed us so that we could prepare. They decided the lecturers. We are also part of the lecturers for this program. The rest of the work will be done by us.

We are a unique institute for radiation technology in Korea. We were able to successfully develop about 30 good products, and we were able to give them to small and medium companies so that they can grow with our technology. From now on, we will give our technological output to the companies located here in the industrial center.

***21st Century:*** **So there is an immediate technology sharing that will occur in such an environment.**

**Kim:** Yes, so we are the backbone for the growth of the industrial complex.

***21st Century:*** **It would seem that it would affect agriculture as well, since you are in a very rural environment.**

**Kim:** That is right, but the agriculture portion is very small.

***21st Century:*** **Will you be involved in genetic modification?**

**Kim:** No, our work is not genetic modification, it is actually mutation. This is not the same thing. Mutation is a natural phenomenon that occurs in nature. Take, for example, certain flowers. In nature, when mutation occurs the colors change. Once this happens, we take these new species, so that we can further develop them.

Now consistency is a very important factor, because we will need to produce the exact same color of flower, and this process can be accelerated by irradiating the species of flowers, or grains, or some other thing. So this is an artificially driven mutation.[1]

***21st Century:*** **It's like making nature's natural evolution occur faster.**

**Kim:** That's right! Exactly. This is one of the examples: [pointing to flowers in exhibit booth] This is our national flower,

1. S.Y. Kang, D.S. Kim, and G.J. Lee, "Genetic Improvement of Crop Plants by Mutation Techniques in Korea," , Vol. 1, No. 3, pp. 7-15, December 2007. http://mvgs.iaea.org/pdf/PMR2007120103.pdf


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*Matthew Ehret-Kump interviewing Dr. Young-Jin Kim at KAERI's exhibit booth at the International Meeting of Irradiation Processing.*

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*KAERI's gamma irradiator and (inset) the cobalt source.*

the Rose of Sharon (*Hibiscus syriacus*). We have developed a very small one, so that we can keep it. This is a new breed.

***21st Century:* Is this utilizing the gamma ray technology?**

**Kim:** That's right. A low level of gamma rays. Because if you use a high level, the seeds will die. Right now we use only gamma rays, but we will eventually also use electron beams.

***21st Century:* Can you mention some examples of how this technology in agriculture benefits a nation?**

**Kim:** Well, Korea sometimes suffers from typhoons and hurricanes. When there are heavy rains and heavy winds, the problem is that the rice probably can not withstand them, and the stalks collapse. The crop production will decrease quite significantly. But with the gamma-ray induced mutations, we can create species of crops that can withstand heavy winds and rains. This is one area.

Another is that you want to produce food which has better taste and is more nutritious. In this way, this technology can be used very effectively.

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*The gamma phytotron, where gamma ray technology is used to create artificial mutations in plants, such as new flower colors of more nutritious crops.*

***21st Century:* The LaRouche political movement has promoted the policy of doubling world food production very soon. And with an increasing world population this is very necessary. It seems like your program will be very necessary as a model for other nations to follow if we are to meet this challenge.**

**Kim:** Yes. That's right. There are three ways of breeding new types of species. The first is the conventional way called cross-breeding. The second is the radiation-induced mutation, and the third is genetic modification.

These days, the Americans, especially Cargill, which is the most powerful industry, creates these GMPs (genetically modified products). Today about 50 percent of the world's beans are genetically modified organisms, GMO. But Europeans strongly object to it. They do not want to get GMO crops imported to their countries. Our government has the same stance, but most of the imported beans are GMO.

Now … the radiation-induced mutations are very safe, because this is just the acceleration of naturally occurring phenomena. So we are pushing our government to increase our capability of using this technology. Over the years, we did not have a plan to secure and protect our own crops. Significant amounts of our national crops are already gone—stolen by the industrialized countries. This is the case for most of the underdeveloped countries.

***21st Century:* I know that there has**

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*Researchers checking on gamma treated plants.*

**been a call internationally in recent months to put a cap on food prices, which are artificially rising due to speculation and biofuels. And to do so as a collaborative effort of national governments which act now to protect their populations from the collapsing speculative financial system. This sounds like something that would be very necessary for South Korea to participate in, with China, Russia, India, and various other nations, like the United States.**

**Kim:** Yes, that's right. But the real problem is that the big companies have already secured the different crops of so many types from the underdeveloped countries. We were a very poor country about 40-50 years ago, so that's why we didn't know how to protect ourselves, because there was no person who was concerned about this, or thought that this was very important. Nowadays, our government has realized that this is very important, and we need to protect our own crops.

***21st Century:*** **Absolutely. Food sovereignty is the right of every nation.**

**Kim:** Yes, that is the case. So this is one area, and a biological resource too.

***21st Century:*** **And nuclear energy as well.**

**Kim:** Yes. You know Korea ranks sixth in the world in terms of nuclear energy. Thirty-five percent of our electricity comes from nuclear, and now our government has planned to increase that to 45 percent.

***21st Century:*** **Even with all of the fear and hysteria being created around Fukushima?**

**Kim:** Oh yes. That's right. Our energy dependency is around 97 percent. We import oil, coal, and everything, so we only have a 3 percent control of our own energy. We also produce around 30 percent of our own food, and 70 percent is imported.

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*The seed storage room at the Advanced Radiation Technology Institute, where new seeds are banked for research. The Institute is pushing the Korean government to increase the use of radiation-induced mutation.*

Nuclear energy is concentrated energy, meaning you don't need much land. So nuclear energy for Korea is not a choice. It is one of the most important strategies for survival. Otherwise we have no choices. That is why our government is pushing very hard these days. Because of the Fukushima accident, the anti-nuclear activists and environmental groups strongly oppose it.

***21st Century:*** **Well, they're being fed with a lot of fearful propaganda that has no connection with science.**

**Kim:** You are right. But the problem is that public acceptance is most important, and the public doesn't believe scientists these days, all over the world.

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*New rice cultivars bred by radiation to withstand heavy winds and rains.*

***21st Century:*** **Do you think your government has been doing a good job at educating the population of South Korea on the necessity of nuclear energy?**

**Kim:** We do. . . .

***21st Century:*** **Because the governments have completely failed in Europe.**

**Kim:** Our government sponsors nuclear public relations institutes, and these organizations continue educating the public, starting with the primary schools. So this is the current situation, but still, some people are not familiar with the science and engineering, and they tend to listen to the anti-nuclear activists because they always use very sensational issues, even though they are not true. They say that because of the nuclear plants nearby, that the baby cattle are born with no brains. That's propaganda.

***21st Century:*** **If anyone is born with no brains, it's those pushing this propaganda.**

**Kim:** That's right! But this is the case. And it is also the case that we have a very difficult time to prepare the spent fuel, to store it, and this is currently the big issue.

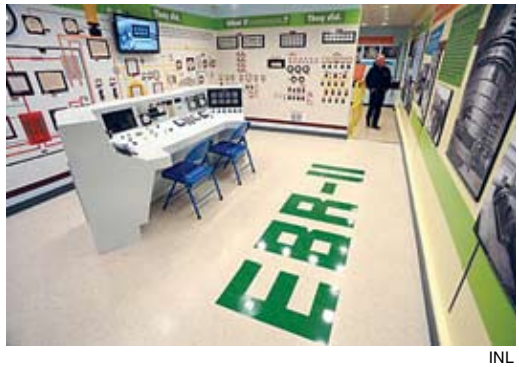
**21st Century: Do you have any policy to reprocess the spent fuel? Is that a national intention?**

**Kim:** We now have one big program, which is the sodium-cooled fast reactor.[2] The fast reactor is fueled by reprocessed fuel. For this we are developing pyroprocessing.[3]

2. *A National Historic Engineering Landmark: Experimental Breeder Reactor 1, Idaho National Engineering Laboratory,* by the American Society of Mechanical Engineers, June 15, 1979, is an informative pamphlet tracing the historical process which led to the construction of the first nuclear reactor capable of producing more fuel than it consumes.

3. Kee-Chan Song, Hansoo Lee, Jin-Mok Hur, Jeong-Guk Kim, Do-Hee Ahn and Yung-Zun Cho, "Status of Pyroprocessing Technology Development in Korea," *Nuclear Engineering and Technology,* Vol. 42, No. 2 (April 2010).


*Korea ranks sixth in the world for nuclear energy, with 35 percent of the nation's electricity coming from nuclear. Shown are Korea's nuclear plant sites.*

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*Korea's sodium-cooled fast reactor, now under development, is based on the experience in the United States with the EBR-II fast neutron reactor, which operated for 30 years and demonstrated that this type of reactor can be safely shut down in the event of a serious accident. Here, part of the new EBR-II display at Idaho's Experimental Breeder Reactor-I Atomic Museum.*

This technology was also developed at the Argonne National Laboratory in the United States, 30-40 years ago.

At yesterday's keynote speech at the conference, one of the professors talked about pyroprocessing. The first power reactor of this type was EBR-1, the Experimental Breeder Reactor, first demonstrated at the Idaho National Laboratories in 1951.

This was the first fast neutron reactor that produced power, electricity. After that they built EBR-2, which had around 100 megawatts electric power. EBR-2 used a metal-type fuel and a sodium coolant. The EBR-2 researchers wanted to demonstrate to the public worldwide that they had successfully developed the sodium-cooled fast reactor. They also wanted to demonstrate that, even in the most serious accidents, the EBR-2 could be safely shut down without any significant radioactivity release to the environment.

As the speaker explained yesterday, one of the more serious accidents is the loss of coolant. So, in testing the EBR-2, they stopped the primary pump, and they showed that the temperature goes up slightly and then comes down very quickly, and then the reactor stays in a stable condition.

The other serious accident which the EBR-2 is able to handle is the failure of the secondary heat exchanger, so that the reactor heat inside cannot dissipate beyond a limit to the outside.

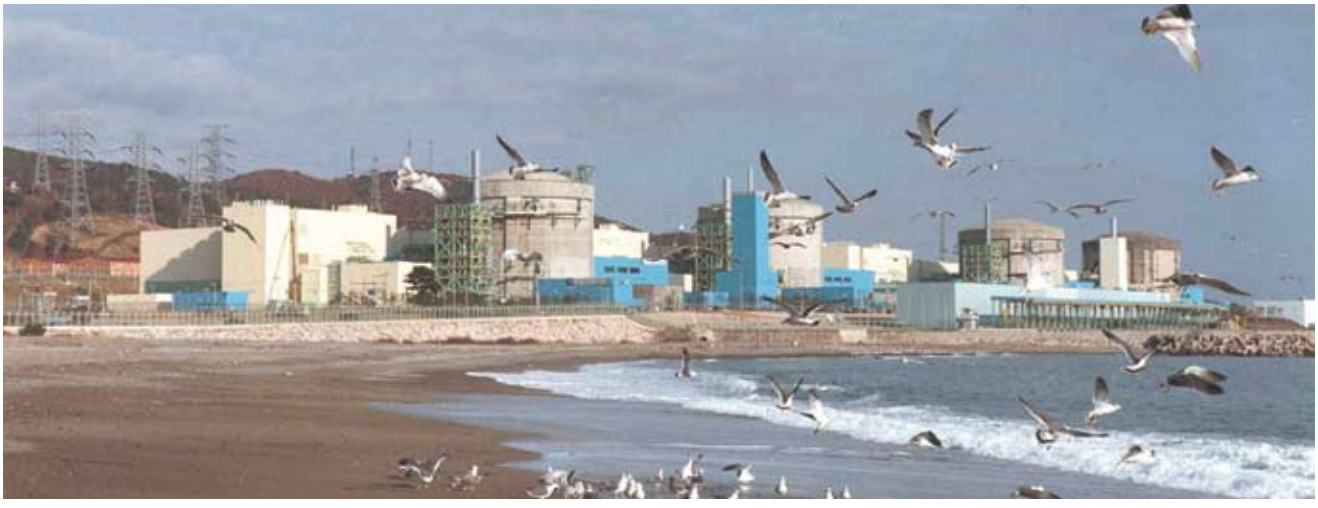
***21st Century:* So its like a melt-down-proof system.**

**Kim:** Just like that. The problem with the Fukushima accident in Japan, was that they lost the cooling capability. With the EBR-2, they deliberately created a loss of power in the coolant primary pump, and then demonstrated that even with the reactor in this condition, it can be shut down without any problems very safely.

But to get back to your 21st Century about reprocessing: the problem is that the Korean government is not allowed to reprocess.

***21st Century:* Why not?**

**Kim:** Because that's the policy of the United States. Even though we have developed this pyroprocessing further, we recently had an agreement. The United States does not think that this pyroprocessing-reprocessing technology is "proliferation resistant." The United States and other industrialized countries are worried about the proliferation of nuclear technologies because of the nuclear bomb, that a country could make an atomic bomb, like North Korea.



*Canadian Nuclear Association The Wolsong Nuclear Plant, one of the four CANDU-type reactors operating in Korea. The CANDU reactor uses natural uranium as fuel.*

That's why they keep us from actually handling the spent fuel. So we have changed it from reprocessing, to the reuse of spent fuel. Yesterday, the speaker mentioned that the CANDU reactor produces a lot of spent fuel (four times more than the PWR, Pressurized Water Reactors) because the CANDU doesn't use any enrichment; it uses only natural uranium as the fuel.

***21st Century:*** **It's ironic that here in Canada where we have this capability, we have not produced a reactor since the 1980s.**

**Kim:** I know! We actually have four CANDU reactors operating in Korea.

AECL/CANDU

*Korean nuclear operators trained on this CANDU simulator in Canada.*

***21st Century:*** **Well, it seems Canada has a lot to learn from South Korea's experience, and other nations do too.**

**Kim:** Yes, that's why we have 21 nuclear power plants in operation. Of that, 4 are CANDUS, and 17 are PWRs of different companies. The first 4 PWRs were constructed by Westinghouse. We even had French President Mitterrand visit our country to sell us their PWRs. The deal was that we were to buy their power reactors, and they would return our old cultural records, which were stolen by the French.

***21st Century:*** **Really!? The French stole these ancient books?**

**Kim:** Yes. In the late 19th Century, the French navy actually invaded Korea.

***21st Century:*** **I didn't know that. And they took these cultural heritage pieces to France? And so, in agreeing to a technology transfer, they also agreed to return the books?**

**Kim:** But, it did not happen. Mitterrand did not keep his promise. Now early this year, France allowed the return—on lease!

***21st Century:*** **You're so fortunate! You get to borrow your own cultural heritage books.... Well, Mitterrand had a history of being a skunk.**

**The world has a lot to learn from the experience of South Korea right now, and we hope that greater collaboration occurs.**

**Kim:** I hope so too. Because the Koreans are special in the sense that the parents are always eager to educate their children, and education is the first priority. Always. Parents will sell everything to keep their children in school. They even send their children to the industrialized countries like the United States, or Japan or Europe, and this is one of the strongest aspects of the Korean economy.

We emphasize education and that means we build a higher level of human resources. I think that this is the main reason that Korea was able to develop very quickly.

***21st Century:*** **Well, the children are the future.**

**Kim:** Another thing, is that we kept the Confucian tradition.

***21st Century:*** **You didn't go to Taoism?**

**Kim:** No. That's why we have a great deal of respect for our parents, good family unions, and relations, international cooperation.

We had a collaboration with AECL (the Atomic Energy of Canada Limited) to build a multiple purpose research reactor, the Hanaro, with 30 megawatts thermal power, a world-class research reactor. This was in the middle of the 1980s. I came here to Montreal two times.

At that time we didn't have any of the infrastructure for basic science. This was our first high flux research reactor, and we successfully developed and constructed the 30-MW Hanaro. Hanaro means unity in Korean, or uniqueness, because this Hanaro is the only one in operation anywhere in the world.

Even though the fuel bundles were originally developed by AECL, all other work was done by ourselves! Now, at that time, Nordion had a plan to build two 10-MW Maple reactors.... The Canadian firm Nordion is one of the big guys in radioisotope production and export.

The reason we decided to collaborate with AECL on that project is because in the early 1980s, Nordion asked AECL to build radioisotope-only reactors, reactors that are dedicated to producing radioisotopes. So we chose AECL because their plan was two years ahead of us. That means, if they made a mistake, we could learn it right away, and that would be a very safe way to develop our own reactors.

Now, the problem was that their plant was delayed and delayed. So, we have no reference.

***21st Century:*** **That made you the pioneers all of a sudden.**

**Kim:** Yes. We became the pioneers, and the contract has been changed. The initial contract read that all responsibility for the development was on AECL, but just three years later everything had changed. That means we are now on our own, and AECL is only supplying some major components and collaborating in some areas, but is not the main contractor.

We took around 10 years to complete this project successfully. Hanaro was completed in 2005, 10 years from its start. However, because this was our first research reactor, our regulatory body did not allow us to operate it at full power. So our plan initially was that we would operate the plant at 10 megawatts, and then by showing our experimental data to our regulatory bodies, that we would be able to increase it another 5 megawatts. It took almost nine years to come to the final stage.

***21st Century:* What's the full potential?**

**Kim:** Full potential is 30 megawatts. But now the reactor is not at full potential, but rather at what is called design power. Design power means that we can increase the power beyond the 30-MW limit. If we can prove experimentally that we can operate the reactor at 35 MW, then we can increase it.

Design power now is 30 megawatts. We can run this at 30 megawatts for 24 hours per day for up to three weeks, with 10 days for maintenance and refueling. So all together, we operate for about 230 days per year, continuously 24 hours, and this is quite an achievement. Now, initially, after we constructed the reactor, there was no experimental facility whatsoever! Nothing. So then in 2005, our government decided to give us the money to build the necessary instruments, meaning it took another 10 years to install all the equipment for basic science and industrial application. I was the one who made a plan to build what you call the cold neutron system....

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*The 30-megawatt Hanaro research reactor, used for producing radioisotopes, was developed with Canada's AECL, and completed in 2005. Because Canada discontinued its two similar Maple reactors, KAERI is pioneering this new design. Hanaro now has the instrumentation for use of cold neutrons. Construction for a second research reactor for isotope production will begin next year. similar reactors.*

Cold neutron means that the wavelengths are almost nanoscale in size. A neutron behaves both like a particle as well as a wave. Cold neutrons can be applied to characterize nanomaterials as well as biomaterials. For example if you have to transfer a medicine through the membrane.

The advantage of the cold neutron is that its energy is very low. The energy is comparable to the excitation of the atom. This way we can investigate the characteristics of the dynamic properties of the materials. The cold neutron research facilities are available only in some countries, such as France, where Cadarache has the most powerful research reactor; and Germany as well, located in Munich. Japan has it. The National Institute for Standards and Technology has it in the USA, and also the Oak Ridge National Laboratory. And those are the only nations that have it.

***21st Century:* We have been advocating for many years, that a much better metric for economic value is not determined by markets, but rather by isotope production. We've produced various papers around the idea of an isotope economy. That the best way to measure the health and wealth of a nation is by its capacity to produce the greatest density of isotopes and bring them into use in human society.**

**Kim:** Maybe you can talk to the Nordion people, because the AECL gave up. They successfully constructed two 10-MW Maple research reactors, but they couldn't get a license from the government regulatory body, because of some safety problems. They tried to solve it for five or six years, and then they gave up. They announced that they wouldn't continue this process, and are now under lawsuit from Nordion.

***21st Century:* Well, look at the mess of the Chalk River isotope production reactor, and that was a 1950s technology.**

**Kim:** That is the NRU, the National Research Universal reactor. It gave them a problem because it was too old. The operation was not stable, and it was sometimes out of service.

There was another isotope production reactor located in Petten, the Netherlands, which was also 50 years old. It had a problem in the primary circuit, and so they had to shut down that reactor for almost two years.

That meant that the supply of technetium-99m was very unstable.[4] And that lack of medical isotopes is why we had troubles in the medical sector in the diagnosis of cancers. That is why the OECD called all of its member countries, and had a discussion on resolving these issues about three years ago. At the end, the OECD gave each country the duty to produce a certain amount by 2016, which is five years from now.

We had our quota. So our government decided to build a new research reactor mainly to produce radioisotopes. The government approved the plan this year, and we can start the construction of this new research reactor as of next year.

***21st Century:* I'm sure that the collaboration between the western nations, and eastern nations around these great endeavors will only improve as people come back to reality. So thank you very much for giving me your time.**

4. For more on this, see the interview with Dr. Guy Turquet de Beauregard, "We Need to Expand Medical Isotope Production!" in *21st Century,* Winter 2009-2010, pp. 46-50.