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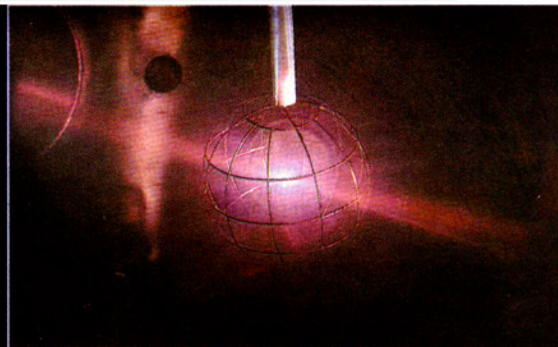
Fusion's future



COURTESY OF UNIVERSITY OF WISCONSIN FUSION LAB

A UW team has developed a fusion method, called inertial electrostatic confinement, that uses a small-scale chamber.

Graduate student Ross Radel prepares a sample for an enriched uranium detection experiment at the University of Wisconsin-Madison Fusion Technology Lab where researchers are working to expand the uses of fusion technology.

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Energy promise unfulfilled, but it may help fight disease or terrorists

By HARVEY BLACK

Special to the Journal Sentinel

Fusion is not being envisioned solely as an energy source anymore.

A major problem right now is it takes much more power to fuse certain hydrogen elements than what is produced.

Now, researchers at the University of Wisconsin-Madison are developing the technology for medical purposes and detection of nuclear explosives.

For more than 30 years, UW-Madison engineering professor Gerald Kulcinski has been one of a number of researchers at universities and federal laboratories working to find an economically feasible way to use fusion to make electricity.

While Kulcinski, who heads UW-Madison's Institute for Fusion Technology, and other scientists remain committed to their goal, he and his UW colleagues have begun to look for other uses for fusion technology.

"It was about the early part of the 1990s, we decided to ask ourselves, 'What could you do in the next five or 10 years, to use fusion for, if not for power?' " said Kulcinski.

The technology involves the fusing of light elements, such as deuterium and tritium — both of which are forms of hydrogen. The result is energy that can be used to create electricity.

Because these elements essentially are limitless, fusion backers envision an endless energy supply.

Fusion reactions can produce a number of subatomic particles and forms of radiation. Kulcinski and his colleagues pondered how they could use them.

One answer was to use high-energy protons from fusion reactions to make radioactive isotopes that could be used in medicine.

Such isotopes often are used in diagnosing cancerous tumors, by means of PET scanners.

Patients are injected with short-lived radioactive glucose and their bodies are scanned to locate tumors, which are voracious consumers of glucose, and so are relatively easily found by a scan.

At major medical centers, cyclotrons readily produce such isotopes.

"But if you live in Minot, North Dakota, where you don't have these facilities, how do you make short half-lived isotopes?" asked Kulcinski.

Currently, patients in such rural areas must travel to major cities for such diagnostic procedures.

He developed an inexpensive machine that rural hospitals and clinics could use to generate short-lived isotopes.

"We did this," he said.

A third fusion method

Efforts to generate fusion for electricity use one of two techniques: magnetic fields in multi-ton doughnut-shaped chambers called toruses; or powerful lasers.

The chamber Kulcinski and his colleagues have developed uses a third fusion method, one relying on electric forces and inertia to force the particles together.

It is called IEC, or inertial electrostatic confinement.

Using a small-scale fusion chamber (about two feet in diameter), he and his colleagues have created high-energy protons as a result of fusing deuterium and a form of helium.

These powerful protons are then slammed into targets such as nitrogen gas or water to produce radioactive isotopes such as carbon-11, oxygen-15 and nitrogen-13. The half-lives of these isotopes are less than 20 minutes.

Wilson Greatbatch, inventor of the implantable pacemaker, described this sort of machine as an "innovative" approach to fusion and has aided its development with a $300,000 donation.

A realistic market

Producing such isotopes would fill an important gap, said Michael Hartshorne, a physician and nuclear medicine specialist at the University of New Mexico Health Sciences Center in Albuquerque.

"With our cyclotron located about 30 minutes away, that fixes it so that carbon-11 (with a half-life of 20 minutes) isn't going to work very well," said Hartshorne, who is not affiliated with Kulcinski's research.

Carbon-11, he notes, is useful for diagnosing prostate and renal cancers, something that the widely used radioactive isotope fluorine-18 can't do, he said.

"There are some spectacular radio pharmaceuticals that are labeled with carbon-11 for prostate cancer, but I can't get my hands on them," he said.

The market for such a device is quite realistic, says Greg Piefer, who recently received his doctorate in nuclear engineering and engineering physics from UW-Madison under Kulcinski.

He has helped found a new company, Phoenix Nuclear Labs in Middleton.

He hopes to commercialize this technology, but noted that there are some hurdles to overcome.

A major one, he said, is getting a high fusion rate of helium and deuterium to produce a high number of protons.

He said that over the past few years, during which he has been involved in the project, the fusion rate has increased about 10,000 times.

"That translates directly into how much isotope you can make," he said.

While the work to develop medical isotopes is supported by private funds, money from the U.S. Department of Homeland Security is supporting the project to use fusion technology to detect nuclear explosives that might be smuggled into the country.

Using a variation of the fusion process used in making isotopes, this technology produces a beam of neutrons that can be focused on a shipping container.

If that neutron source is then turned off, and one sees a stream of neutrons a few seconds later, said Kulcinski, that means there is fissile material or a nuclear weapon inside the container.

"Nothing gives you neutrons on a delayed basis except fissile material," he said.

"To my knowledge this is the first practical application of a fusion confinement system," said Rick Nebel, a physicist at Los Alamos National Laboratory who has been working with Kulcinski on this project.

"It could be commercialized in a couple of years," said Piefer, who is also working on the project.

Using fusion for such "near-term" projects, said Nebel, is important not only for their own sake, but also for the overarching and continuing goal of fusion — the generation of energy.

People would see fusion technology on a small scale — machines that are just a couple of feet in diameter instead of the mammoth ones envisioned to produce energy — being used for rather practical, everyday purposes.

If such projects can succeed, said Nebel, "it would just do wonders for the image of the whole (fusion energy) program."