Fusion research for future energy

by John Watson

The energy crisis ofthe 1970s is no longer a major concern to today's public. OPEC no longer has the industrial west, and the rest of the world as well, in a stranglehold. The cartel has very little power and very little internal stability. The power OPEC had in the past helped to develop an awareness and interest in the alternative energy field. A great deal of research and effort has since gone into developing alternative sources.

Nuclear power, created by harnessing fission reactions, was a replacement for conventional energy sources. Nuclear power, though, is not tremendously popular with the public. It is, statistically, less dangerous than the conventional sources, but the potential is there for current nuclear power plants to be much more harmful.

Research being done at the U of A is aimed at developing the second generation of nuclear power plants. Fusion power plants are (theoretically at least) much cleaner and much safer than today's fission powered reactors. A division of the electrical engineering department, known as the laser/plasma team, is at the forefront of the world in some areas of fusion research.

The team has been a part of the department for about 12 years. It has developed equipment, techniques and expertise that rival any in Canada. The direction of the team's research has recently changed.

"Plasma research has, in the past, been the main direction of the laser/plasma team," said Dr. Robert Fedosejev, a member of the team. Plasma is the fuel that will be used in fusion plants, and it is essential to know how the plasma reacts in the fusion process. The laser team has developed laboratory techniques for studying plasma and its reactions.

The majority of the plasma experiments were done using a carbon-dioxide laser system. The massive system, filling a room the size of the first floor lounge of SUB, is covered with lead sheeting. The sytem was the team's main research laser until recently. "Historically carbon-dioxide lasers were at the forefront of laser technology, now they have become the standard," said Fedosejev. The laser is currently not being used.

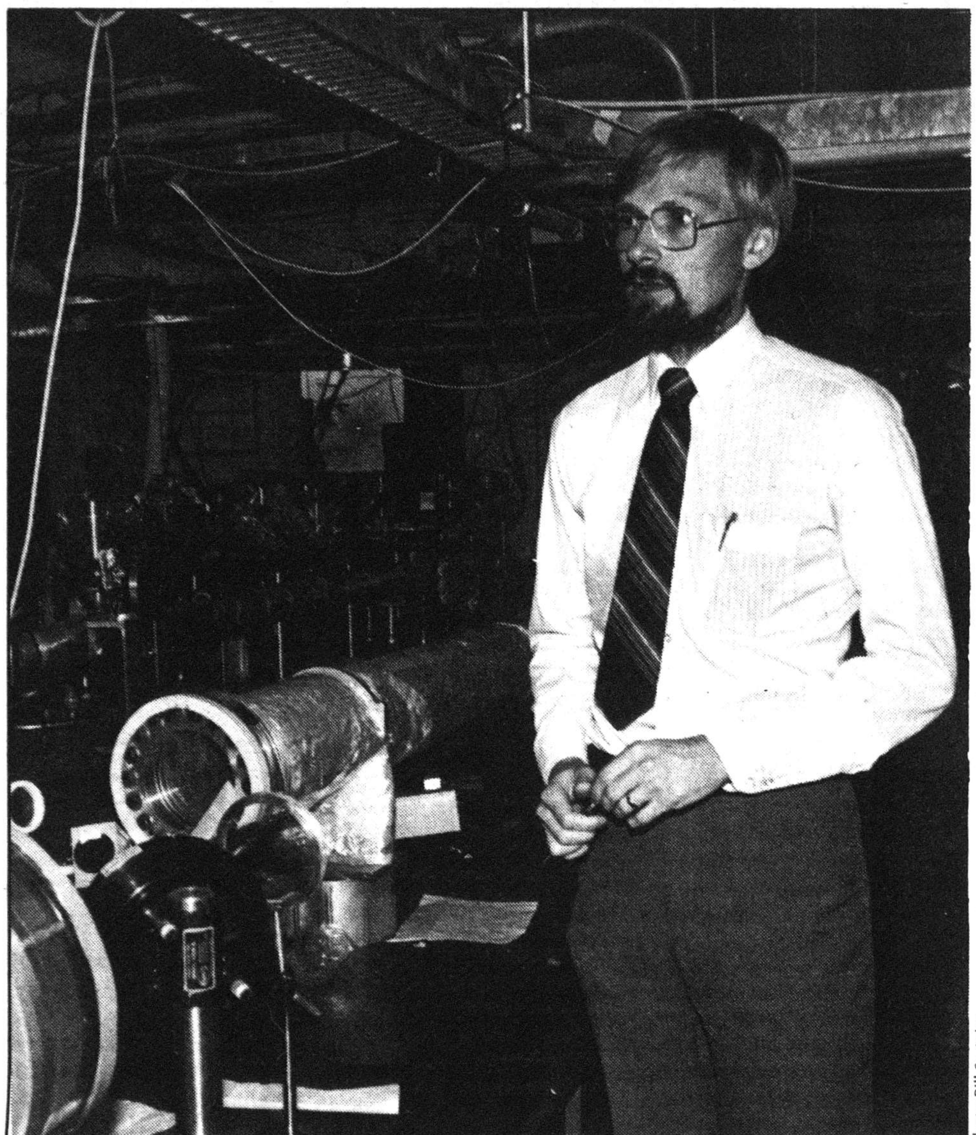

Photo Bill St. John

Dr. Fodosejev in front of the Krypton-Flouride laser

The work now being done by the team is done using a new laser. "the Krypton-Fluoride laser was built entirely at the U of A, as were all of the laser used by the team," Fedosejev said. Lasers are used to ignite the plasma fuel (shaped into very small pellets) in a fusion reaction. The laser sytems at the U of A are not developed for that purpose; they are nowhere near the power necessary for such a project. The research lasers are used to investigate the processes occuring in the fusion reaction and the team is developing techniques and equipment for that purpose. "The Krypton-Flouride (KrF) is a special type of technology, it is not a routine, off-the-shelf, laser system," said Fedosejev. "It is an excimer laser, and incorporates technology that makes it the only one of its kind being used for research in the world."

To make the fusion process a reality is the goal of the laser/plasma team. "The underlying motivation is to develop a feasible fusion system," said Fedosejev. The process is theoretically quite simply — get a small drop of fuel to compress itself to the point where nuclear reactions begin, and produce enormous amounts of heat as a result — simple."

The fuel pellet — the plasma — must itself be very uniform; it is compressed using lasers, which must also be uniform in the way they hit the fuel. The research being done at the U of A is trying to understand how the plasma reacts and how the laser is best manipulated.

Fusion is an appealling alternative energy source. It is the process that goes on in the Sun. It is clean, and if it can be dveloped, it is essentially an inexhaustible energy source.

Whereas fission reactors (all current nuclear reactors are fission reactors) take big atoms and blow them apart, fusion does the opposite. Small (hydrogen) atoms are fused together. Fission reactors need a large amount of fuel to keep the reaction self-sustaining (known as critical mass). Fusion reactors must use very small amounts of fuel and they are consumed very quickly.

The most controversial aspect of nuclear power is the radioactive waste produced. Fission reactors produce a great deal of this and the waste produced by fission will be around for thousands of years. Fusion on the other hand produces mainly non-radioactive waste. The radioactive material it does produce is much less significant; there is less of it, and it remains radioactive for a much shorter time.

The research being conducted by the laser plasma team may in the future help to develop an efficient fusion system. Fusion at the moment is still only useful in science fiction paperbacks. "The reactor at Princeton (an experimental fusion reactor known as a Tokomak) is nearing the point of scientific break-even," said Fedosejev. Scientific break-even is the point where the amount of energy going into the fuel is coming back out again. That is still a long way from being an energy source.

Meanwhile, the laser technology developed by the team is useful to other fields as well. Though not directly related to the fusion team, the KrF laser is useful in producing computer chips. "The current method prints circuit patterns using visible light. Using the KrF laser — and ultraviolet light — the patterns can be reproduced in shorter scale sizes," said Fedosejev.

If successful, this research would mean that micro-chips could be made even smaller than at present. "The research is being looked at intensely by various companies," said Fedosejev.

In the same vein, using x-rays instead of visible or ultraviolet light would again increase the possible reduction of micro-chip size. The laser/plasma's KrF laser is a good possible source of such x-rays. The team may in the future work on developing the KrF system for such x-ray production.

Fusion though, remains the team's ultimate goal. All indications are that the research will continue for some time to come. "I think fusion will be available, as a possible energy source, within two or three decades," said Fedosejev.