Laser Fusion: The ultimate energy source

By ROBERT W. BLY

Controlled thermonuclear fusion is "an inexhaustible high-technology energy source," explained Moshe Lubin, director of the Laboratory for Laser Energetics (LLE).

Housed in a single building located on the South River Campus, the LLE is the home of the $70 million Laser Fusion Feasability Project. The goal of the project is the creation of a controlled fusion reaction through ignition of a fuel pellet by laser beams.

A tremendously powerful laser is needed to achieve fusion, noted Lubin, who pointed out that 38 percent of the project budget is used in the construction of the laser system. The LLE laser system of 24 seperate beams is dubbed OMEGA (omega being the 24th letter of the Greek alphabet).

Construction of OMEGA will be completed in three steps. By October of this year, six of the beams will be fully operational. This system is called ZETA (zeta being the 6th letter of the Greek alphabet) and will operate at a power of 5 terawatts or over 6.7 billion horsepower. By December of 1979, all 24 beams of OMEGA will be operational, but at roughly 40 percent of the system's full power. OMEGA won't be operating at its peak power of 30 to 40 terawatts until December of 1980.

No secrets

No top secret projects center around the LLE, said Lubin, noting that "the work is unclassified. This is designated as a national users facility." This implies that scientists outside of the university and the government and the industries that finance the LLE can still make use of its unique facilities.

Lubin described OMEGA as "an upgraded system of the system Rochester pioneered in Gavett." The Laser Fusion Feasability Project had its headquarters in the basement of Gavett from 1973 until last year, when the project moved into the LLE building.

The money for the laser itself comes mainly from federal sources, while New York state and the UR financed construction of the building, which comprised about 10 percent of the total project cost. Project operations costs are funded by private industries such as General Electric and Exxon, and account for about 52 percent of the expenses.

He estimated that within 20 to 30 years, the construction of working fusion reactors would be feasible, but he noted that before this is accomplished, "Controlled thermonuclear fusion is likely to be replenishing or recharging spent fuel from present day lightwater (fission) reactor technology." This goal will be acheived within 10 to 15 years, added Lubin.

Fusion is "a much cleaner nuclear reaction (than fission) and in itself does not produce any longlife radioactive products" when it is used as a power source, he explained.

He also stressed that, unlike nuclear fission, fusion "is not a chain reaction. If it gets too hot, the fuel simply expands and then it cools down." Lubin pointed out that the fuel used in fusion reactors, heavy isotopes of hydrogen, will not ignite until the temperature of the laser beams exceed 50 to 100 million degrees.

Yet until fusion becomes a reality, fission reactors are a necessary part of our energy program, said Lubin, who vehemently stressed that "present day fission reactors *cannot* explode, because the concentration of nuclear material is nowhere near enough to lead to a massive explosion." One obstacle in the way of those doing research into nuclear energy sources, he said, is that both the public and the bureaucrats do not realize that fission and fusion are not dangerous power sources.

It is the scientists duty to teach the public the truth about such things, Lubin commented, adding that "this is especially vital in this time with so much misinformation and emotional hysteria."

Inside the technology

He explained that at present, two seperate roads to controlled thermonuclear fusion are being explored. The one being pursued by the LLE is called intertial confinement, or laser fusion.

This takes advantage of intertia, or the reluctance of matter to move when a force is applied. The enormous power of the laser beam is used to heat the fuel to fusion temperatures in less than a billionth of a second, insuring that the fusion takes place before the reacting particles fly apart.

The alternate path is to confie charged hydrogen particles in a magnetic field or "bottle," as Lubin described it. Princeton is the leader in this area of fusion research, termed magnetic confinement. So far, attempts at magnetic confinement have met with very limited success.

Lubin indicated that the UR is pursuing the more practical path.

"It looks like laser fusion can be economically attractive in sizes which are about 250 megawatts electric," he said, while magnetic confinement reactors would have to have capacities "of about 1500 to 2000 megawatts electric" to be economically feasible." Another advantage which he pointed out is that the laser apparatus would occupy roughly one fourth the space that the magnetic bottle would.

In addition, the idea of laser fusion has been around for only a decade, while magnetic confinement was discussed as early as the 1940's; it would seem that magnetic confinement is not making rapid progress like laser fusion. Said Lubin, speaking of the LLE project, "We've come a long way in a short time."

"It's all done with mirrors"

The OMEGA system shoots a pulse of monochromatic light at a target pellet of fuel. The pulse lasts for less than a billionth of a second, and requires so much power that the system must shut down for half an hour before another pulse can be fired.

The 24 beams are not aimed directly at the target, but are directed to the fuel pellet by a complicated optical system. "It's all done with mirrors," joked Lubin, who pointed out that the UR is an ideal place for such a project "because we have more optics expertise" than any other university.

Martin Nabut, director of public information for the LLE, agreed that the high level of technological expertise in the university and the city itself were a great boon to the project. Said Nabut, "There's nothing you can order off the shelf - you're working on the cutting edge of technology."

Lubin noted that laser fusion research, like the space program, produced spinoffs from the main research that are technological advances in themselves. He cited that a technique in X-ray generation from laser-plasma interaction has developed as a result of the Feasibility Project, and added that this technique "could be very important for biomedical applications."

Another example of a spinoff is the new class of materials developed by Exxon. These spongey materials are used as targets for the laser, and, according to Lubin, "have the potential for being a significant new fuel."

Think Tank

There are over 120 people working in the LLE, and of those 75 are from the UR. The other 45 are on contract from private companies such as Eastman Kodak, and are primarily systems engineers.

The LLE employs computer specialists, mechanical and aerospace engineers, chemical engineers, theoretical and experimental physicists and optical engineers. Many of the UR people are doing research are pursuing advanced degrees; some are undergraduates.

Lubin said he thinks that involving students in such an important project as laser fusion is vital to the nation's future. He stated that "our reason for being in it (fusion research) is because our business is training the scientific leaders of tomorrow." He added that it is the scientists who must "make the right decisions with respect to the technology...and where to put our resources.

The scientist, as an expert, must inform the politician as to what is the best course of action," he stated, who mused that "we (the scientists) must even become politicians ourselves."

LLE is an ideal training ground for students, said Lubin, who insisted that "they (students) don't sweep floors here. They get involved in a given project."

Martin Nabut added that there is never a lack of work, noting that a "furious pace and long hours" are standard around LLE. The researchers often put in 12 to 16 hour days voluntarily, because "people are here because they're interested in the Mission," according to Lubin.

Energy and superiority

He emphasized that "the

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The Laboratory for Laser Energetics, located on the UR's South River Campus.

A complex optical bench. The laser fusion project makes use of the high degree of optics expertise available at Rochester.

What is Fusion?

Often called the "ultimate energy source," nuclear fusion is the way stars convert matter into energy. In a fusion reaction, the nuclei of very light atoms, such as hydrogen isotopes, deuterium and trituim, "burn" or combine into a heavier atom liberating energy in the process.

Plasma, the raw mateial of stars, is s substance so hot that its atoms are stripped of their electrons and broken down into their basic particles. The high temperature at which fusion reactions take place is not heat in the usual sense, but the kinetic energy of the atomic particles within the plasma. Positively charged atomic nuclei ordinarily repel each other when brought together. Fusion will take place only if the particles are heated-that is, raised to energies which will overcome their repelling force.

The challenge to scientists is to find a way of heating plasma and of keeping it contained at temperatures that will initiate fusion.

Laser light

One method is to use a laser to heat the plasma. A laser (the term is an acronyum for Light Amplification by Stimulated Emission of Radiation- is a beam of coherent lightwaves. Coherence means that all emitted laser light is one color, or frequency, and all the lightwaves are in step, or in phase. Laser light can be so accurately parallel that the beam spreads only a few centimeters in a mile. Thus, its full power can be focused on a tiny spot-such as a deuterium fuel pellet only one fiftieth of an inch in diameter.

The basic requirements for a laser are quite simple: a material with the property of absorbing and realising energy, a container to hold it and an energy source to excite it. UR scientists conduct fusion research using neodymium glass lasers, where the atoms of the rare earth element neodymium are the basis of the laser light. The laser amplifies the light waves by drawing directly upon the energy stores in these atoms.

Reactor design

A "first generation" fusion reactor would use the highly energetic neutrons emitted in the fusion reaction to generate electricity. The neutrons would be slowed down, probably in a jacket of lithium within the reactor, and the heat resulting from the deceleration used to make steam. The steam would, in turn, drive conventional turbine engines to make electricity.

There has been little development of a prototype fusion reactor so far, and we cannot yet build a commercially viable plant with today's lasers.

Adopted from public information pamphlets prepared by the Laboratory for Laser Energetics.

Nightlife in city of Rochester...

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features and a deep voice, but exuded little self-confidence. Realizing that Rick was probably an expert on Rochester night life, we attempted to extract information from him.

While Jim engaged Gerri in conversation Glenn pulled Rick aside and convinced him he was nothing short of a mobster. After offering Rick a winning race tip and arranging a marijuana deal, Glenn was able to obtain the names and location of several prominent gambling casinos. Glenn's act was so convincing he earned the name "Big Glenn" for the rest of the evening.

Rick was a shallow and uninteresting character, so we drained our glasses and left the Silver Fox.

Our next stop was a whore house on State Street. The girls worked out of a storefront adjacent to Kojak's, another topless bar. They claimed to be able to relax and stimulate in a half hour "encounter session." For a price of 20 dollars the model poses topless, and for 25 dollars, completely nude. However the madame made it very clear that tipping is encouraged, "if the customer enjoys himself." We pressed her to elaborate.

"Okay," Jim asked, "if I went back with you for a 20 dollar encounter how much extra would it cost for a blow job?"

"It's strictly up to you and the model," relied the madame.

Suddenly a customer walking in. He was obviously embarrassed to see three young "kids" staring at him, but put forth his request. The madame snapped her fingers and three girls came from behind a curtain, striking sexy poses for the customer. After looking over the merchandise, he made his choice and exited to the back room with the model. Having no intention of following suit, we made an appointment for next week.

The Encore II was a few doors down from the Encounter. As it was ten minutes before closing we were spared the $2.50 cover charge but were forced to pay $1.75 for beer and gave the bartender our last $3.25 for two Budweisers.

All we caught of the show was the curtain call, but we observed a striking difference between the two bars. At Encore II, the dancers descended a spiral staircase coming out of the ceiling. After each girl took her bows, the star of the show made a grand finale by pulling off her G-string to the surprise an delight of the sparse audience. This is a criminal offense.

Annoyed by the price of the beer, Jim questioned one of the barmaids to see if the bartender hadn't upped the price for his own profit. Jim didn't get his question answered, but did learn something about barmaids: They're not all innocent young girls who experienced a string of bad luck. Some of them are low-life degenerates.

This was the case with the barmaid at the Encore II. She answered Jim in speech so slurred it was incomprehensive.

"How could a girl so drunk still wait on tables?" Jim asked Glenn rhetorically.

"She's not high on alcohol," Glenn said sternfaced. "She's probably gone on smack."

Depressed and repulsed by the very thought, we left the Encore II.

After a short stop at an adult book store, and a sight seeing tour of the prostitutes on Main Street, we experienced our most dangerous adventure of the evening: we followed a cop car surveilling two prostitutes.

We crawled along in the right lane heading westerly on Main Street. The officer seemed to be back to the 19th ward making sure they didn't latch on to any gentlemen friends along the way. Judging by how often he checked his rear view mirror, he was getting annoyed by our persistence.

The officer pulled to a stop in the middle of an intersection trapping us behind him. We pulled into the left lane, passed him, and drove to Nick Taho's parking lot. Much to our dismay the cop began following us. After two circles around the parking lot, he pulled us over.

"You were blocking an intersection," said the officer. Realizing it would be useless to argue that the officer had in fact trapped us in that position Jim attempted to explain that we were doing research for a newspaper story. He opened the car door and attemped to get out but the officer kicked the door shut.... "Remain in the vehicle," he said in a monotone.

Jim proceeded to tell our story while the cop checked his license and registration. He seemed not be believe us, so Jim popped out his press card and urged the officer to call the Editor-in-Chief for verification.

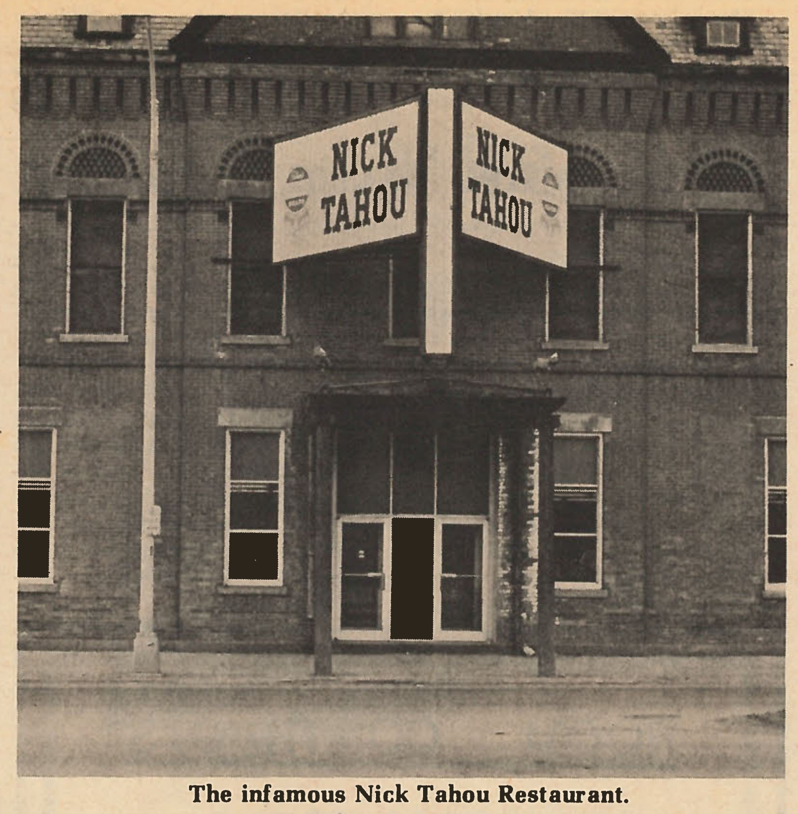
The cop went into Nick Tahou's and did just that but unfortunately Rosenthal wasn't in. Unfortunately because the cop proceeded to call UR security who direct him to Dean Jackson, who was not happy to be woken up at 4:00 am.

Dean Jackson verified that we were students and were members of the *CT* and took responsibiltiy for the matter into his own hands.

When the hour ordeal was over, we proceeded to make friendly conversation with the cop. We asked him why he wasted his time on three innocent college students while there were pimps, prostitutes and pushers roaming the streets. Jim pointed out a shiny red Cadillac with thick white walls as an example: The cop laughed and admitted that the car probably did belong to a pimp, but that "those dudes are so slick it's impossible to nail 'em."

We arrived back at the UR at 5:30 am, with a very unique experience behind us. We were neither enlightened nor repulsed by the Rochester night life, for this goes on in all cities. Our experience left us with a curious numbness. Our senses were assaulted and abused so frequently that by the end of the evening, nothing surprised us. We have no particular urge to relive our experiences but somehow it would be fun treat a friend to the night life in Rochester. Better yet, to open the eyes of the citizens of Rochester to the sights we saw.

Kojak's promises . . . does it deliver?



The infamous Nick Tahou Restaurant.

Fusion...

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common denominator to a high standard of living is inexpensive energy." He also pointed out that an enexpensive enrgy source, such as controlled nuclear fusion, is the key to economic power and the maintenance of superior technology. If we do not develop fusion power, Lubin reasoned, we will not have inexpensive energy sources and "we still not have any specific overwhelming technological edge."

While the supply of fossil fuels such as coal and oil are rapidly becoming exhausted, he noted that the heavy isotope fuel needed for fusion "is available from sea water through a simple extraction process." And since the supply of seawater is unlimited, the fuel available for fusion reactors is "virtually inexhaustible," explained Lubin.

While he said he views fusion as "the ultimate power source," he added that "this is not to say that other alternatives should not be developed." "Solar energy is very useful," but was quick to note that solar energy "cannot, by any stretch of the imagination, power industry," he commented.

Still a challenge

While scientists at the LLE are positive that controlled fusion will be achieved within a few decades, he observed that they "haven't done it yey." Lubin, a Professor of Mechanical and Aerospace Engineering who has a Ph.D. from Cornell, must spend three or four days a week just fulfilling management and administrative duties in the lab. He spends only two days a week pursuing his own purely scientific research.

The lab runs 24 hours a day, seven days a week. When asked why all the researchers at the LLE devote so much of their time to the project, Lubin said that "we're on kind of a continuous high...the challenge is still out there."