A graser breakthrough at Los Alamos

Besides realizing the President's goal of making nuclear weapons "impotent and obsolete," the graser promises a revolution in science and economy. Charles B. Stevens reports.

As I wrote in the last issue of this magazine, the most promising laser technology being developed for deployment as a strategic defense system is the free electron laser. On a more long-term basis, however, work on the gamma ray laser (graser) offers the potentiality for a completely new range of applications, strategic, scientific, and technological. Gamma radiation is electromagnetic radiation at wavelengths shorter than those which usually characterize x-rays. The short wavelength graser is the next step beyond the x-ray laser.

In a May 9 press release, Los Alamos National Laboratory reported on a major new development which would allow them to realize the shorter wavelength gamma ray laser, a device which has a potential, directed-energy firepower millions of times greater than the x-ray laser. Besides its obvious military applications, truly realizing President Reagan's goal of making offensive nuclear weapons of mass destruction "impotent and obsolete," the graser promises to provide the means to increase general economic productivity by more than 100-fold. It will revolutionize every aspect of science and technology and generally create the basis for harnessing more coherent forms of nuclear energy than those existing today, such as nuclear fusion and fission. Based on their recent breakthroughs, Los Alamos scientists report that the first graser prototypes could be developed in as little as three years.

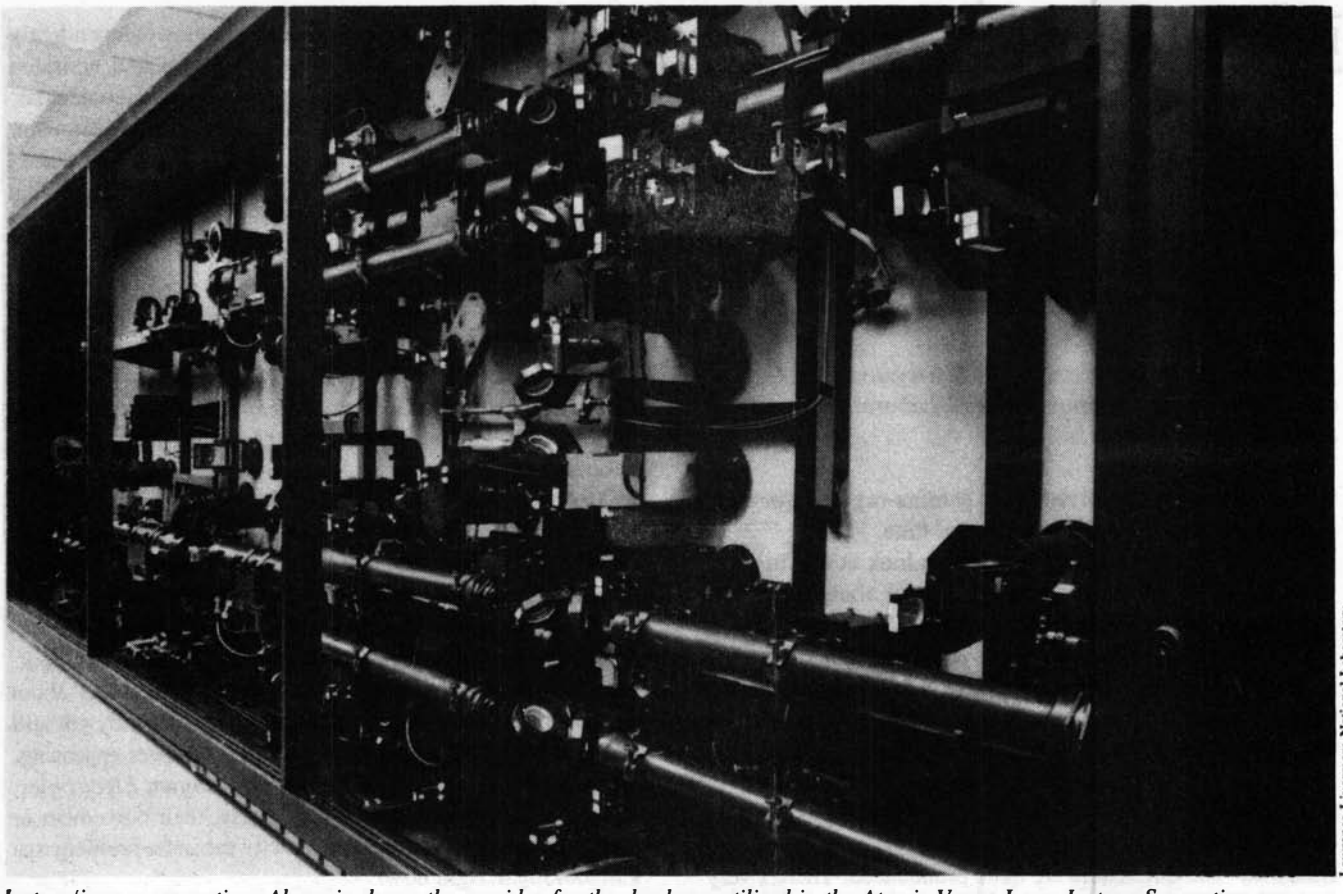
Scientists working under the direction of Dr. George Baldwin, the father of the U.S. graser effort, have successfully completed the first of a crucial series of experiments that can lead to the world's first nuclear laser. The device would generate a coherent and intense beam of gamma rays.

The particular experiment involved was aimed at purifying the materials that would power the graser, and represented the first of a series of "proof-of-principle" tests in largely uncharted scientific domains. A graser would be directly powered by nuclear transitions, or what are scientifically termed isomers. (An isomer is an atomic nucleus that has been put into a metastable "excited" state due to neutron irradiation in a nuclear reactor.)

In order to construct a graser, scientists must find the right isomer and be able to purify it. Until now, no one has been able to purify isomers.

The experiment

The Los Alamos experiment consisted of purifying an isomer of mercury—the material found in ordinary thermometers. This was achieved by irradiating mercury with beams



Lawrence Livermore National Laboratory

Isotope/isomer separation: Above is shown the corridor for the dye laser utilized in the Atomic Vapor Laser Isotope Separation process. More than 2,000 optics are shown in the photograph. Excited isotopes—isomers—must be separated from unexcited ones to construct the material medium for crystal gamma ray lasers.

from a conventional laser. The incident laser light vibrated the mercury atoms. By tuning the incident laser light to the proper wavelength, the Los Alamos scientists were able to get the excited mercury isomer to vibrate more than the others. The result was that the desired mercury isomer "broke free" from the rest.

According to Los Alamos scientists, the next step will consist of incorporating the purified isomers into a solid crystal that would be the heart of the graser. When that is done, they will then have to develop a way to pump energy into the isomer sufficient to catalyze gamma ray lasing, without destroying the crystal. The graser beam would then be emitted from the crystal.

Applications

The potential applications and implications of the graser are vast and wide-ranging. First, as a potential beam weapon against offensive nuclear weapons of mass destruction, the graser would be without equal. It possesses the "least action" quantum of energy for disabling nuclear weapons, through shock effects, because of the extremely high density of the energy which it is capable of depositing upon a missile. The coherent beam of gamma rays can be directed over ranges of millions of miles and tuned to penetrate and instantaneously disarm nuclear warheads through nuclear transmutations. The highly penetrating gamma rays would selectively zero in on heavy elements like uranium and plutonium. It could also conceivably even penetrate and disable warheads on missiles in underground silos.

Most exciting is its scientific potential: The graser will provide the essential tool to see inside the atomic nucleus itself. This could reveal and harness entirely new forms of "coherent" nuclear energy. In the same manner as is being developed for the x-ray laser, the graser could provide the means for making three-dimensional, atomic-scale moving pictures of living matter—except, naturally, with much finer temporal and spatial resolution. The same techniques can obviously revolutionize our understanding of the dynamics and structure of non-living matter, too.

It could also perform delicate surgery in place of scalpels and other surgical tools, in a manner similar to today's lasers, but again, with far better refinement. Because of its short wavelength, the graser offers to provide the means for increased worldwide communications and eventually, even interstellar data links with satellites engaged in exploration of space beyond the solar system.