fraction of a second. One method used is called "multiplexing." The laser beam output is amplified 20 or 30 times in power through splitting the beam into many pulses and stacking these pulses in space and time by using many correctly spaced mirrors. Full-scale demonstration of multiplexing should come in early 1985. Multiplexing can be combined with techniques of phase conjugation and Raman pulse compression to further amplify and improve the quality of excimer laser outputs.

KrF excimer lasers would be space-based, while xenon-chloride and xenon-fluoride excimer lasers are leading candidates for ground-based laser weapons operating with orbiting mirrors.

Free-electron lasers

Developments in 1984 show that "free-electron laser" (FEL) technology is becoming mature for both ground basing and possible space basing.

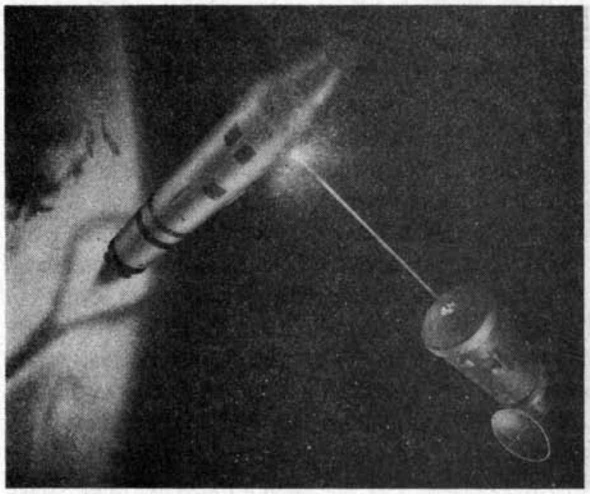
The Dec. 13, 1984 *Defense Daily* quotes Dr. Lowell Wood of Livermore: "One particularly interesting [non-nuclear strategic defense system] . . . involves the use of large lasers located on the ground with mirrors in space focusing their beams onto attacking missiles with lethal results. A handful of such lasers, probably having an aggregate cost of about a billion dollars, working with a small number of mirrors thrown up into space by small but powerful rockets when onset of strategic war was detected, might completely defeat even a massive attack in a highly reliable fashion. . . . Such a system could even more readily defeat attacks carried out with bombers and cruise missiles, thereby completing a robust defense against all present forms of large-scale nuclear attack."

Such a potentiality is opened up by the free-electron laser amplifier. This would allow conventional lasers to be scaled up in power by three to four orders of magnitude.

For the first time, in the fall of 1984, Livermore Laboratory demonstrated high-power amplification with a "pure" FEL system. The device was powered by their experimental test electron beam accelerator (ETA). A 30,000-watt microwave input pulse was amplified to 80 million watts. In 1985 the device will be tested on the Livermore Advanced Test Accelerator (ATA) at higher powers. The larger ATA will extend this result to infrared wavelengths (100,000 Angstroms) and 100 billion watt power levels.

The more than three order of magnitude amplification translates into a corresponding reduction in the demands made for target acquisition or optics. The normal one to two seconds that a conventional laser must remain on its target, can be significantly reduced while the tolerance for divergence allowable for the beam is increased.

Scientific breakthroughs of 1984 in beam defense



Among the highlights of the past year's developments in scientific research were:

1) Testing of x-ray lasers, which once perfected will be able to remain precisely and brightly focused for vast distances;

2) Demonstration of short wavelength excimer lasers, including the krypton-fluoride excimer laser module at Los Alamos National Laboratory;

3) Demonstration of two varieties of free-electron laser—one high-powered laser that could be deployed in two years. These can be "tuned" to maximize their lethality against the target;

4) Development of well-focused neutral particle beams;

5) Demonstration of high-energy elementary particle beams (muons) against nuclear warheads;

6) Demonstration of the propagation through the atmosphere of high-energy particle beams;

7) Demonstration of conventional ABMs—missile-intercept in space (HOE) and in the atmosphere;

8) Demonstration of missile protection systems—advanced infrared missile detection systems;

9) Full development of techniques for propagation of laser beams through the atmosphere (phase conjugation and adaptive optics).