tortions of a beam in transit are removed. Lasers on a space-based platform could, therefore, be used to intercept ICBMs in flight.

The United States is currently developing DEW research through the Defense Advanced Research Projects Agency (DARPA) and its Space Defense Technology programs. Three main projects now underway are Talon Gold, ALPHA and LODE, all interrelated in the development of a space-based laser. In addition, the USAF has coupled a Hughes pointer-tracker with a laser aboard an Airborne Laser Laboratory (ALL). The ALL is very large and exceptionally manoeuverable, filling essentially the entire cargo bay of the plane. Both the Navy and the Army have laser programs as well, although their development has not achieved the "height" of the Air Force program.

The first practical laser came to light in 1960, when two American scientists developed the ruby laser which generated only one watt of power. The gas-dynamic laser was produced in 1967, giving 100 watts. Then, only a year later, a carbon dioxide laser was developed with an output of 60,000 watts. About this time, DARPA formed the High Energy Laser Research Group (HELRG) to study the use of lasers for weapons. Soon, the electric-discharge laser was developed, followed in the mid-1970's by the chemical laser capable of producing several megawatts.

A laser weapon was first successfully demonstrated in 1973 at the HELRG facilities at Kirtland AFB, New Mexico. A gas-dynamic laser, using a telescope to sight and point, shot down a drone aircraft, albeit a slow-moving one. Then, in 1978, a deuterium/fluoride laser shot down three TOW antitank missiles travelling at 500 mph. However, this required eight tries and a huge generating station to produce the needed 300-watt output. Nevertheless, the move to space seems only a short step away.

Particle beam DEWs, on the other hand, are not quite so far along in development. Their main advantage is that a beam need not "cut" through a missile, but only play upon its guidance circuits to be effective (although in actual operation, a beam would certainly raise the temperature of the missile).

As was true of lasers, there exist defences against particle beams, as well as problems in their operation. Any beam of particles (electrons, protons, neutrons, etc.) will tend to diverge because of the charges on the individual components, although neutron beams would be less susceptible to this. Furthermore, distortions in the geomagnetic field would wreak havoc with a beam, kinking and warping its path. In space, an Anti-ballistic Missile (ABM) DEW would need a radar-pointing system, which could be jammed or confused by chaff or decoys. Also possible is the detonation of a nuclear weapon in the atmosphere to disrupt a beam's propagation channels. It seems that, as with most weapons, an improvement in offence merely initiates an improvement in defence.

Despite these drawbacks, DARPA is currently operating the Particle Beam Technology Program, which has a directive to produce the required technology by 1987. One of its tasks is the "generation of low-divergence neutral beams for space applications". Clearly, this is the ASAT DEW system.[21] The USSR also seems to be engaged in research into particle beams for space weapons.[22]

21 Much has been written about the development of particle beam weapons. A very readable article is that by Parmentola, J. and Tsipis, K., "Particle Beam Weapons", *Scientific American*, V. 290, no. 4, 1979, pp. 54-65. It is excellent in its description of the technology and provides useful information on the weapon's weaknesses and vulnerabilities. The authors de-emphasize, however, the intense research devoted to the DEW development at the present time. While it is probably advisable to be cautious in discussions on DEW development, one must also recognize the advances of the past decade. Clearly, DEW weapons are edging closer to reality.

22 Main, R. *op cit.*, note 20.