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Directed Energy Weapons Testing Raises Issues

Testing directed energy weapons (DEW's) represents a special challenge to the 21st Century tester. Continuing research and development of lasers and high-power microwave devices drives a need for the test community to create the test technology needed to evaluate these new devices.

As in other types of weaponry, the tester must devise testing procedures for the two aspects - measuring the effects of the weapons directed against a threat target, and measuring the resistive characteristics of our equipment to attack from a DEW. To appreciate the tester's challenge, let's look at the three categories of DEW's - lasers, high-power microwave (HPM), and charged particle beam (CPB) devices - and some related test issues.

DEW's generate highly concentrated radiation to be beamed at a small target area. The radiation used may be at optical wavelengths (as in lasers), radio frequencies (as in microwave beams), or other regions of the electromagnetic spectrum. DEW's employing lasers, HPM, and CPB potentially may impose major changes in the character of combat over the next 20 years.

Development of such weaponry is proceeding along two broad lines:

a. Antisensor weapons, for suppressing or damaging visible sensors, including human eyes, as well as infrared and microwave sensors.

b. Heavy-duty weapons, for vehicle kill against aircraft, missiles, and spacecraft.

This latter category, with sufficient power to attack the hull of even light-skinned aircraft or missiles, is highly unlikely to be on the tactical battlefield weapons within the next 30 years. (F1) STAR 21, National Academy Press, August 1992.

Laser Testing Issues

Lasers have advanced the farthest among the three technologies. Limited deployment of entry-level antisensor lasers has already taken place, with some trial use in combat. Heavy-duty laser weapons in experimental configurations have been tested successfully as well. HPM technology is not yet adequate to support the weapon concepts envisioned, but is progressing toward that goal. CPB weapon use is farther in the future, but

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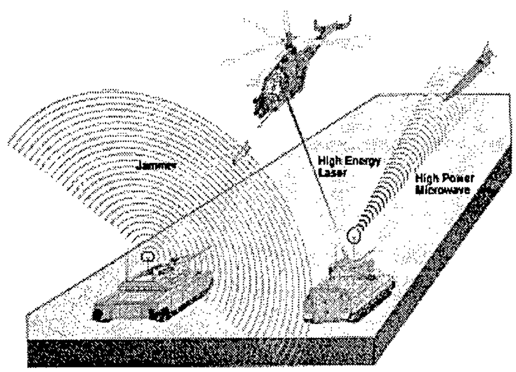
potentially is the most lethal. Their technical feasibility is uncertain.

The targets of relevance for lasers fall into two classes - optical sensors and airborne objects, such as aircraft, helicopters, tactical and strategic missiles, and spacecraft. The main operational distinction between these two target classes is the delivered fluence (J/cm^2) or irradiance (W/cm^2) necessary to inflict the required level of damage. Optical sensors generally are very soft targets when attacked in band and within their field of view; the required target fluence ranges from less than 1 mJ/cm^2 to about 1 J/cm^2.

Airborne objects are killed, typically, by penetrating the thin outer skin and thermally damaging critical elements such as guidance, controls, fuses, structural members, oil lines, and fuel tanks. The fluence required for such damage ranges from 1-30kJ/cm^2.



Laser testing issues include facility safety, attenuation/dispersion measurement, materials, characteristics measurement, dynamic (on-the-move) measurements, pointing accuracy, laser modeling and simulation, and handling highly toxic/corrosive chemicals.

HPM Testing Issues

Test technology for high-power microwave weapons is essentially an extension of laser test technology. HPM's have shown the capacity to disrupt or damage communications, electronics, and weapon systems, and to disable the control subsystems of both airborne and ground vehicles.

The pervasiveness of microelectronics throughout military systems has increased their vulnerability to HPM's. For instance, the use of microelectronics in aircraft and helicopter flight control systems and in ground-vehicle engine-management systems has made the basic control of this equipment susceptible to HPM interference. Using lighter and stronger composite materials instead of metallic structures in new vehicles also will aggravate the problem of radiation susceptibility by eliminating the natural Faraday Cage shielding that an enclosed metallic structure can provide. Peak power levels exceeding tens of gigawatts should be anticipated within about 20 years.

HPM testing issues include safety, attenuation measurements, materials characteristics, modeling/simulation of HPM devices, effects on communications, and effects on humans.

CPB Testing Issues

The testing challenge posed by CPB weapons is somewhat less urgent. If they can be realized as conceived by advocates, they will be the most lethal of the three DEW's.

The technical feasibility of the CPB is uncertain, depending upon the development of *compact accelerators*. The basic concept is to alter the linear transport geometry of the traditional linear induction accelerator into a spiral or circular configuration. This would allow the same accelerator module to repeatedly act on a circling swarm of charged particles, until they reached the desired velocity.

The appearance of CPB weapons within the next 20 years is doubtful.