FACT SHEET

UNITED STATES AIR FORCE

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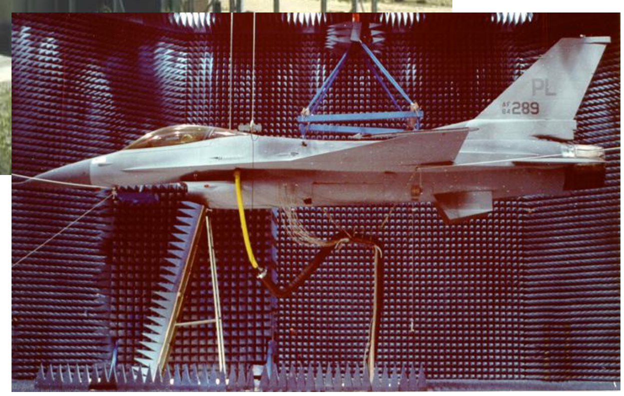
High-Power Microwaves

High-Energy Microwave Laboratory



F-16 in Anechoic Chamber

Department of Defense research on high-power microwave technologies and their weapons potential is centered at Kirtland Air Force Base, New Mexico, within the High Power Microwave Division of the Air Force Research Laboratory's Directed Energy Directorate.

Division scientists are exploring equipment and methodologies for generating high-power microwave energy and accurately propagating that energy to a target. Included are efforts to assess the effects of those high-power microwaves on various targets. Work is also ongoing on the feasibility and utility of placing compact high-power microwave systems aboard various Air Force platforms.

The general public is familiar with the technology as it applies to household microwave ovens that use this form of energy to penetrate and cook food. Whereas a typical microwave oven generates less than 1,500 watts of power, the Division is working with equipment that can generate millions of watts of power. When microwaves encounter modern microelectronics-based systems, the results can be disastrous to the electronics – causing systems to "burn out" and fail or function improperly. This heavy reliance on electronic components in today's weaponry makes high-power microwave weapons attractive.

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A short burst of high-power microwave energy can be lethal to electronics while having no affect on humans operating the equipment. The low-collateral damage aspect of the technology makes high-power microwave weapons useful in a wide variety of missions where avoiding civilian casualties is a major concern.

High-Power Microwaves have a potential in command and control warfare, in suppressing enemy air defenses, and against tactical aircraft or unmanned aerial vehicles. Efforts within this division include a variety of technology areas:

Source and Antenna Development: Research and development on narrow- and wide-band high power microwave sources produced devices that are among the world's most powerful microwave pulse emitters, and Impulse Radiating Antenna technology demonstrated the focusing of ultra-wide-band radiation into a conical beam with a beam width of approximately a single degree. Also, Hydrogen Switch technology demonstrated its effectiveness in a recent advanced concept technology demonstration.

Beam Development: Solid-state switch technology offers an ultra-wide-band beam, but with the ability to make an antenna conform to the skin of a system. With the promise of high efficiency, the technology also provides the ability to steer the beam and phase the radiation into an extremely narrow beam. In the narrow-beam high-power microwave area there are several technologies under development including a Magnetic Insulated Line Oscillator. This offers the promise of compatibility with explosive pulse generators that can convert tremendous energies into microwaves.

Vulnerability Efforts: The Division maintains anechoic chambers – one large enough to house a fighter aircraft – and is conducting evaluations on the effects of high-power microwaves on U.S. systems in an effort to develop protections against microwave threats.

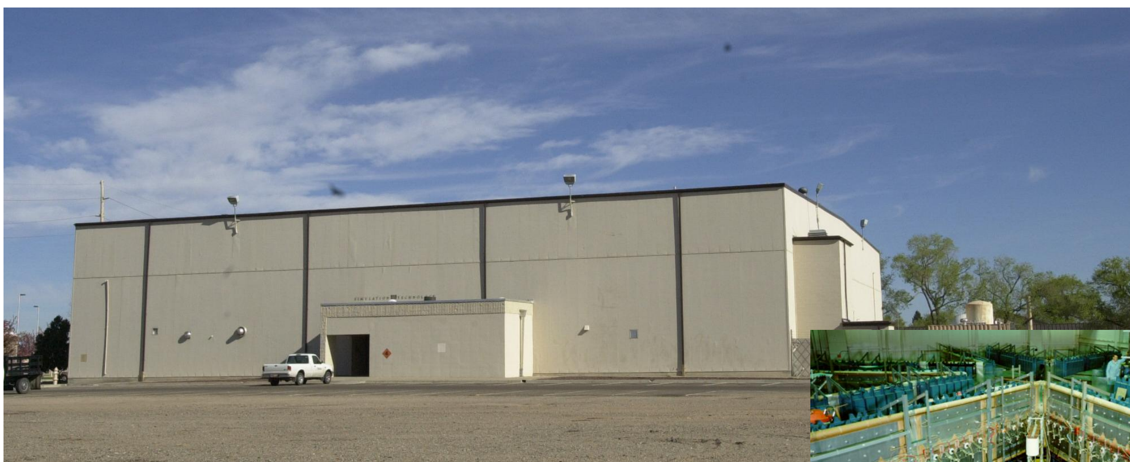
High-Power Microwave Modeling and Simulation Efforts: Models and simulations are being developed to investigate the effectiveness of high-power microwave technology – also synonymously referred to as radio frequency technology – to assess the effectiveness of such systems in disabling targets. This is essential to determine the utility of high-power microwave technology for military applications. One way these assessments are performed is with a computer code called RF-ProTEC (Radio Frequency-Propagation, Transmission, and Effects Code) that models and simulates the high-power microwave system antenna emission pattern, the propagation of radio frequency radiation to and into a target, and the effect on the target. The code may be used to assess the lethality associated with a specified set of scenario parameters or, alternatively, to determine those problem parameters that will optimize lethality. Ultimately the Division hopes to determine which of the many stages of a complex high-power microwave system-to-target process are most influential in determining target lethality.

Active Denial Technology: Related to high-power microwaves is this millimeter wave technology that penetrates less than $1/64^{th}$ of an inch into an individual's skin to stimulate the person's pain sensors into feeling severe pain without physical damage. The technology is proving extremely effective as a non-lethal means of turning away an aggressor.

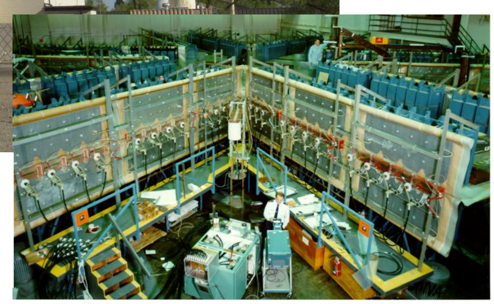
Vehicle Stopper Program: The High Power Microwave Division is supporting the United States Department of Justice in researching the potential for radio frequency devices to stop vehicles in a non-lethal manner. Experiments are underway to establish how modern auto-mobile electronics respond to radio frequency radiation and evaluate any susceptibility to selected waveforms. Such a device capability would be useful in military and civilian appli-cations as an alternative to the high speed chases commonly employed to stop suspect vehicles. This capability could also be used to provide entry control or establish a point defense while not injuring suspects or bystanders.

High-Power Microwave Facilities:

The High Energy Microwave Laboratory consists of 25,484 square feet of laboratory and administration space for the test of high-power microwave technologies.



High Power Systems Facility



Shiva Star Fast Capacitor Bank

The 34,261-square-foot **High Power Systems Facility** conducts research into the military appli-cations of high-energy pulsed power systems. The facility houses Shiva Star, the Air Force's largest pulsed power system. Shiva Star will store nearly 10 million joules of energy (equal to 5 pounds of TNT). It produces a pulse of 120,000 volts and 10 million amps in one-millionth-of-a second to produce a power flow equivalent to a terawatt. Shiva Star has evolved from a 1 mega joule system in 1975, a 2 mega joule system in 1979, to its final form as a 10 mega joule system in 1982. Shiva Star has been used over the years for many different types of experiments such as pulse compression to increase energy in the pulse, plasma liner implosion for production of x-rays, solid liner implosions to compress matter to high density and pressure, compact toroids for generating high-energy plasmas, and simulation of explosive pulsed-power generators. In addition, the facility is used for diagnostics of high-energy pulsed-power systems by using magnetic probe arrays, laser interferometry, time- and space-resolved optical spectroscopy, x-ray grazing incidence, photodiode array spectroscopy, x-ray pinhole photography, and fast optical photography.

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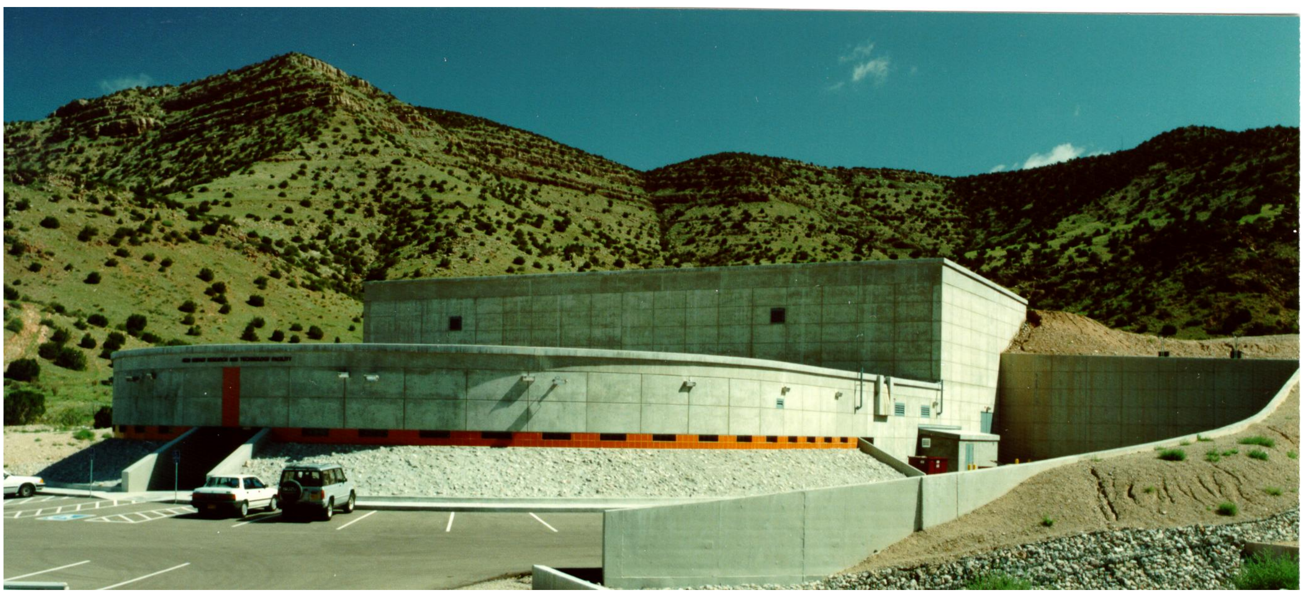
The High Energy Research and Technology Facility is a premier Air Force Research Laboratory capability for research, development and transition of advanced weapons technologies.

This $9 million, 26,827 square-foot, facility provides a unique capability for the development of high-power microwaves, high-energy advanced pulsed-power (including explosive devices), and very-high-energy plasmas. It also provides a research environment for exploring a variety of related technologies. The facility's remote location in the Manzano Mountains on Kirtland Air Force Base is coupled with a unique construction, which is designed to withstand blasts and intense radiation from a variety of sources, including high-energy microwaves and x-rays. The result is a cost-effective and timely capability for transitioning critical technologies to the point where they can be applied to weapons systems.



Located in a canyon in the Manzano Mountains in the southeast portion of Kirtland, the High Energy Research and Technology Facility has a four-story-high bay laboratory, 80 feet by 150 feet, with concrete roof and walls four feet thick for blast and radiation shielding. The high bay includes two bridge cranes, cable trays, a 12-foot-deep pit for intense radiation source experiments, and access tunnels to an explosive firing area near the high bay. Up to 1,000 pounds of high explosives can be safely detonated in this area to produce hundreds of mega joules of electrical energy needed for advanced experiments. The facility also contains offices and smaller laboratories where advanced weapons technology experiments and demonstrations can be conducted safely and securely.

The Facility was designed to scale high-power microwave and high-energy plasma concepts that were pursued for many years in the Laboratory's basic research and exploratory development efforts. It was difficult to advance these concepts with the limited facilities available before this facility was completed. With this facility, technologies can be advanced to a weapons level. Also, advanced weapons environments can be created, allowing scientists to assess the potential threat of these weapons to United States military systems.

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Although the Laboratory's high-power microwave technology is considerably advanced the High Energy Research and Technology Facility is essential in conducting many of the critical experiments still needed to assess the feasibility of the technology for operational systems.

Compact, high-energy pulsed power is an enabling technology for many advanced weapon concepts and effects simulation devices. The High Energy Research and Technology Facility is designed to play a major role in the Air Force Research Laboratory's development of next generation, high-energy pulsed-power devices. Research and development includes the generation and conditioning of large amounts of electrical energy needed for advanced weapon technologies.

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(Current as of September 2002)