STARFIRE OPTICAL RANGE AT KIRTLAND AIR FORCE BASE, NEW MEXICO

Posted 3/9/2012 **Printable Fact Sheet**

Freedom to maneuver in space is critical to meeting the United States Air Force's mission to fly, fight, and win in air, space and cyberspace. The ability to exploit the characteristics of space gives the warfighter a competitive edge in virtually all engagements.

Additionally, space allows the United States to watch the entire globe on an almost "real time" basis, getting instantaneous information. To maintain space situational awareness, the Air Force conducts research in laser guide star adaptive optics, beam control, and space object identification.

As satellites get smaller and the number of space objects increases dramatically, research in imaging and identification of space objects is paramount to meeting the Air Force's mission.

This facility leads the industry changing technology of laser beacon adaptive optics for military uses and civilian applications such as astronomy. It is a major component of the Air Force Research Laboratory's Directed Energy Directorate.

The SOR operates one of the world's premier adaptive-optics telescopes capable of tracking low-earth orbiting satellites. The telescope has a 3.5-meter (11.5 feet) diameter primary mirror and is protected by a retracting cylindrical enclosure that allows the telescope to operate in the open air. Using adaptive optics, the telescope distinguishes basketball-sized objects at a distance of 1,000 miles into space.

In addition to the 3.5-meter telescope, the SOR includes two additional major optical mounts: a 1.0-meter beam director and a 1.5-meter telescope. All are capable of tracking low-earth orbit satellites and all are equipped with large scale, high performance adaptive optical systems and high resolution cameras.

Two additional 1.0-meter telescopes are currently under construction. Other instrumentation includes numerous smaller telescopes and beam directors, multiple laser systems, and a variety of optics, electronics, and mechanical laboratories.

Nearby the SOR is the Telescope and Atmospheric Compensation Laboratory (TACLab). This facility includes extensive optics, electronics, computer, and mechanical laboratory space for equipment design, construction, and testing before integrating with telescopes and other experiment hardware. The building also includes a large mirror coating chamber for the required periodic recoating of the Starfire Optical Range's 3.5-meter telescope's primary mirror. Similar large mirrors from local astronomical observatories may also be recoated here.

The SOR and TACLab staffs include physicists, mathematicians, astronomers, electronic and mechanical engineers, optical designers and technicians, sensor and computer specialists, laser technicians, meteorologists, electricians, plumbers, welders, machinists, and a variety of specialists.

3.5-Meter Telescope Details
The primary mirror of the 3.5-meter telescope was cast in a spinning furnace. The lightweight, honeycomb-sandwich primary mirror weighs 4,500 pounds and has a one-inch-thick glass face sheet. The surface is precisely polished to 21 nanometers, or 3,000 times thinner than a human hair. The mirror is supported by 56 computer controlled actuators to maintain its shape while the telescope is moving. Installed in August 1993, the mirror received "first light" images on February 10, 1994.

A dynamic feature of the 3.5-meter telescope is the protective enclosure that collapses around the telescope through a 35-foot-diameter shuttered opening in the roof. It consists of three, 9-foot high cylinders, each 70 feet in diameter.

The enclosure's cylindrical operating mechanism is often compared to an inverted collapsible cup used by campers. Such a method has two major advantages over conventional domes that are normally equipped with narrow slits: the enclosure does not have to be rotated at high speed while satellite tracking, and it improves image quality by releasing warmer "trapped" air, negating temperature fluctuations, that could create optical distortions.

The protective enclosure was emulated when building a telescope on Starfire Optical Range's sister site in Maui, the Air Force Maui Optical and Supercomputing Site (AMOS), which houses a 3.6-meter telescope. Both sites perform complementary research and on occasion perform experiments together.

Thermal control of the telescope and facility is essential to maintain the highest image quality. A unique feature of the 3.5-meter telescope facility is the removal of heat by a closed-cycle water system chilled by a large "ice house" located ¼ mile from the telescope. The concept is to make ice in the daytime and store it in an underground pit for use at night. Unlike conventional air conditioning systems, this method prevents heat from being released into the air near the telescope.

The SOR is widely recognized as one of the world's leading adaptive optics and beam control research sites. With its work in field experiments in the technology areas of real-time atmospheric compensation, atmospheric turbulence physics, and target acquisition, pointing, and tracking, the Starfire Optical Range is truly a national asset.

The 30-foot pit beneath the floor of the physical plant can hold 4.5 million pounds of ice. These propane-fired boilers can generate up to 2 million BTUs for hot water, which is also supplied to the 3.5-meter facility. Very precise temperature control of optical labs and equipment is achieved by mixing the right proportions of hot and chilled water which then conditions air and equipment in the facility.

Air Force Research Laboratory Directed Energy Directorate
3550 Aberdeen Ave SE, Kirtland Air Force Base, New Mexico 87117
505-846-5304 DSN 246-5304
Current as of 2009 March 23