



# FACT SHEET

# UNITED STATES AIR FORCE

Air Force Research Laboratory, Office of Public Affairs, 3550 Aberdeen Avenue S.E., Kirtland AFB, NM 87117-5776  
(505) 846-1911; Fax (505) 846-0423  
INTERNET: <http://www.de.af.mil/factsheets>

## 3.5-Meter Telescope

The Starfire Optical Range houses the world's premier adaptive optics telescope 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 unique retracting cylindrical enclosure that allows the telescope to operate in the open air. Using adaptive optics, the telescope is able to distinguish basketball-sized objects at a distance of 1,000 miles into space.



This world-class optical research facility, located on a hilltop site (6,240 feet above sea level) in the southeastern portion of Kirtland Air Force Base, New Mexico, is the center for Air force strategic optical research. The Starfire Optical Range's primary mission is to develop optical sensing, imaging, and propagation technologies to support Air Force aerospace missions. It is a major component of the Air Force Research Laboratory's Directed Energy Directorate.

The primary mirror of the 3.5-meter telescope was cast in a spinning furnace, polished by the University of Arizona's Steward Observatory Mirror Laboratory in Tucson. The lightweight, honeycomb-sandwich primary mirror weighs 4,500 pounds and has a one-inch-thick glass facesheet. 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 941 actuator adaptive optics system is now operational.

A unique feature of the 3.5-meter telescope is the protective enclosure which consists of three 9-foot-high cylinders, each 70 feet in diameter, that collapse around the telescope through a 35-foot-diameter shuttered opening in the roof. 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 for satellite tracking, and it improves image quality by releasing warmer "trapped" air that could create optical distortions.

Wind buffeting is reduced by the telescope's very stiff structure and high-torque motors and by angular acceleration sensors which control fast-steering mirrors designed to optically cancel out wind induced jitter. The enclosure was built by Coast Steel of Vancouver, British Columbia.

-MORE-

The combined weight of the telescope, gimbal, optics, and support structures exceeds 100 tons. The telescope sits on a massive steel-reinforced concrete pier that weighs more than 700 tons and which is isolated from the rest of the facility and anchored in bedrock with long steel rods. Contraves USA of Pittsburgh, Pennsylvania, constructed the telescope, gimbal, structure, controls, secondary mirror, and auxiliary path optics; Bradbury and Stamm of Albuquerque, New Mexico, built the facility and concrete pier.

Thermal control of the telescope and facility is essential to maintain the highest image quality. A unique feature of the 3.5-meter 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 30-foot pit beneath the floor of the physical plant can hold 4.5 million pounds of ice. 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 can be achieved by mixing the right proportions of hot and chilled water which then conditions air and equipment in the facility.

The Starfire Optical Range leads the development of laser beacon adaptive optics for military uses and civilian applications such as astronomy. The objective over the next several years is to develop and demonstrate laser beacon adaptive optics on the 3.5-meter telescope. The knowledge gained with the 1.5-meter telescope serves as a foundation for advanced techniques to be used on the larger telescope.

Total cost of the 3.5-meter telescope, enclosure, laboratories, physical plant, and all supporting facilities was \$27 million. The research and operations staff is comprised of approximately 80 military, civilian, and contractor personnel. The staff includes 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 other specialists.

-AFRL-

(Current as of January 2001)