USAF / C3 Supersystem

Mission Description and Budget Item Justification:

This Advanced Technology Development program demonstrates advanced directed energy and optical imaging concepts. Speed-of-light weapons and long-range, high resolution optical imaging through the turbulent atmosphere offer significant payoffs for many Air Force missions, such as theater missile defense, suppression of enemy air defenses, and control of space.

This program has already demonstrated many major technological breakthroughs such as removing significant atmospheric distortions from optical transmissions (e.g., laser beams) and producing small, relatively high power laser diode phased arrays. Major emphasis areas include: high power microwave and high energy laser technologies; long-range optical imaging; and high power laser diodes and diode arrays. Because of the unique effects associated with high power microwaves there are many potential applications ranging from low power disruptions to high power destruction of electronic devices.

Thus, a wide range of high power microwave technologies are being developed. Within high energy lasers the emphasis is on developing methods to increase the power on target. This is done by continuing to remove more of the atmospheric degradations and to develop more efficient laser devices. Long-range optical imaging offers high resolution images of space objects from the ground for applications such as satellite status assessments. High power diodes offer great potential for very small optical sources at many wavelengths for applications such as infrared illuminators and infrared countermeasure sources as well as high data rate secure communications. This PE will continue to develop a wide range of directed energy technologies for many DOD applications. Note: Congress added $27 million for laser radar and excimer technologies in FY 1996 and $10 million for space laser imaging and $5 million for laser-induced microwave imaging (these were the efforts under the FY 1996 excimer program) in FY 1997 which explains the perceived decease in FYs 1998 and out.

STARFIRE OPTICAL RANGE AT KIRTLAND AIR FORCE BASE, NEW MEXICO *Posted 3/9/2012*

Freedom to maneuver in space is critical 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
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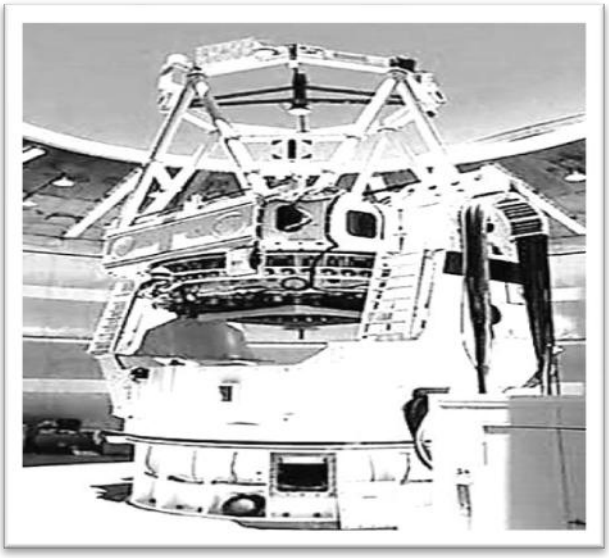

AEOS TELESCOPE/ AMOS in MAUI

The current AEOS 3.67-meter telescope is a yoke and azimuth bearing. The major instrumentation resides in laboratories located several floors below the telescope. AMOS telescopes include 1.6 meter telescope, an 80 centimeter Beam/Director Tracker, and a 60 centimeter Laser Beam Director. A major upgrade to AMOS will be the Advanced Electro-Optical System (AEOS), a 3.67 meter telescope scheduled for first light in 1997. AEOS will have seven coude' rooms for various experiments, as well as conventional Cassegrain positions located on the mount itself. Tenth Annual AMOS Technologies Conference brings together more 630 scientists, engineers, and technical managers from ten countries, including China, Japan, Italy, and Russia…The Relay Mirror Experiment (RME), funded by SDIO and managed by Phillips Laboratory, operated in Maui, utilized existing AMOS assets as well as requiring the construction of additional facilities at the observatory as well as a satellite control and laser propagation facility at sea level near the town of Kihei. Phillips Laboratory received the SPIE Technology Achievement Award for 1991 for the dramatic success of RME.

1988 AMOS participates in Surveillance, Acquisition, Targeting, and Kill Assessment (SATKA) Integrated Experiments, using the 1.2-m telescope and long-wave infrared (LWIR) AMTA sensor.

1990 The Relay Mirror Experiment is conducted; it is the first successful relay of a laser from a ground station to an orbiting relay mirror and back.

USA - New Mexico

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Alamogordo Amateur Astronomers
c/o Paul Carnes
1502 Jefferson Avenue
Alamogordo, NM 88310
Telephone: 505-437-4505
WWW: http://www.zianet.com/mikemosier/astro/astro.htm
Founded: 1986
Membership: 20
Activities: observing * education
Coordinates: 105°00'00"W 32°00'00"N H1,310m
City Reference Coordinates: 105°57'00"W 32°54'00"N

Alamogordo Astronomy Club (AAC)
c/o Jackie Diehl
International Space Hall of Fame
Highway 2001
Alamogordo, NM 88310
Telephone: 505-437-4857 x2840
505-437-5857
Electronic Mail: garfield@sunspot.noao.edu (Brian Armstrong)
WWW: http://www.zianet.com/mikemosier/astro/astro.htm
http://www.zianet.com/aacwp/
Activities: education * observing * flighting light pollution
City Reference Coordinates: 105°57'00"W 32°54'00"N

Albuquerque Astronomical Society (TAAS) (The_)
• See "The Albuquerque Astronomical Society (TAAS)"

Apache Point Observatory (APO)
2001 Apache Point Road
P.O. Box 59
Sunspot, NM 88349-0059
Telephone: 505-437-6822
Telefax: 505-434-5555
Electronic Mail: <userid>@galileo.apo.nmsu.edu
WWW: http://www.apo.nmsu.edu/
Founded: 1984
Staff: 7
Coordinates: 105°49'14"W 32°46'49"N H2788m (IAU Code 645 & 705)
City Reference Coordinates: 105°49'00"W 32°47'00"N

Astronomical Society of Las Cruces (ASLC)
P.O. Box 921
Las Cruces, NM 88004
Electronic Mail: adbailey@acca.nmsu.edu
WWW: http://www.zianet.com/aslc/
Founded: 1951
Membership: 56
City Reference Coordinates: 106°47'00"W 32°18'00"N

CapellaSoft
P.O. Box 1182
Cloudcroft, NM 88317
Telephone: 505-682-1183
1-888-4-CAPELLA (USA only)
Electronic Mail: info@skyhound.com
WWW: http://www.skyhound.com/
Founded: 1992
Staff: 1
Coordinates: 105°44'02"W 32°57'11"N
• Software producer
City Reference Coordinates: 105°46'00"W 32°58'00"N

Clovis Astronomy Club
3517 Corlington Lane
Clovis, NM 88101-3012
Telephone: 505-763-7455
Founded: 1988
Membership: 11
Activities: star parties * education
Periodicals: (12) "Newsletter"
Coordinates: 103°11'45"W 34°28'66"N H1326m
City Reference Coordinates: 103°12'00"W 34°24'00"N

Goddard Planetarium (Robert H._)
• See "Roswell Museum and Art Center, Robert H. Goddard Planetarium"

Institute of Meteoritics (IOM)
• See "University of New Mexico (UNM), Department of Geology, Institute of Meteoritics (IOM)"

Langmuir Laboratory for Atmospheric Research
• See "New Mexico Institute of Mining and Technology (NMIMT), Langmuir Laboratory for Atmospheric Research"

LightPath Technologies Inc.
3819 Osuna Road NE
Albuquerque, NM 87109
Telephone: 505-342-1100
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1-800-472-3486 (USA only)
Telefax: 505-342-1111
520-884-8611
Electronic Mail: <userid>@light.net
WWW: http://www.light.net/
http://www.lightpath.com/
Founded: 1985
Activities: glass manufacturer
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801 University Boulevard NE
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Electronic Mail: lodestar@lodestar.phys.unm.edu
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Periodicals: "The Star"
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http://sst.lanl.gov/nis2astro.html
http://www.lanl.gov/
http://mentor.lanl.gov/
http://mioruilt.lanl.gov/ (Los Alamos Astrophysics Group - LAA)
http://mioruilt.lanl.gov/fho/ (Fenton Hill Observatory - FHO)
City Reference Coordinates: 106°19'00"W 35°53'00"N

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Telefax: 505-665-3003
Electronic Mail: <userid>@laln.gov
WWW: http://www.lanl.gov/
http://mentor.lanl.gov/
Founded: 1980
Activities: theoretical astrophysics * modelling stellar collisions * stellar evolution * structure and evolution of the universe * SN * gamma-ray sources * general relativity